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MALBROOK S'EN VA'T EN GUERRE.

WHATEVER else electric lighting may be accountable for in this country, it seems likely to completely absorb the splended intellect of the British aristocracy, either in its financial aspect or in the fascinations of its practical *modus operandi*. It would be quite an interesting study to compile a list of the dukes, earls, lords, viscounts, and honourable gentlemen who are now dabbling with the light of the future. Probably the bulk of them are interested in electric lighting schemes from the commercial point of view, another batch affect the engineering problems, and yet a third pose as authorities on both the questions involved, and ventilate their profound wisdom and learning in the pages of society journals. Naturally no one is averse to the British aristocrat who, with his vast pecuniary resources, can materially assist in pushing on a new and hopeful industry; neither is there any need to cavil at the sight of a titled gentleman turning to good account his university education in furtherance of a great profession; but it is a question whether blue-blooded amateur *litterateurs* ought not to be tabooed, for, as our readers are aware, it has more than once been our painful duty to call attention to the baneful nature of their essays. In reality, they are, of course, to the technical reader perfectly harmless; but in their own little *coterie* their playful utterances are apt to influence well regulated persons whose knowledge of the subject is of a still more limited nature than their own. The latest contribution of this character on the subject of electric lighting is from the pen of the Duke of Marlborough, whose well-known sporting proclivities would naturally lead to the belief that anything of a serious nature could not reckon upon his Grace as an advocate. Still we live and learn, and in the columns of the *New Review* we find him, in company with the Lord Chief Justice of England, Andrew Lang, and other justly celebrated writers, posing as an authority upon a subject which "our only electrician" finds difficult enough to grasp.

His lordship refers in a deprecating way to his somewhat dry introduction, but here he does himself a great injustice, for it has made us positively merry. In speaking of secondary batteries the true sportsman comes to the fore when he explains that connecting up in series can be more clearly expressed as in *tandem*, and his definitions of electrical units are almost as sportive. He assures us that any current over 1,000 volts is dangerous to the touch, and then gravely asserts that the next great advance in electrical science must be looked for in "converting down" from 10,000 to 2,000 volts. Furthermore, we find him later on giving utterance to this alarming statement: "Unfortunately we cannot light our houses with arc lights, which take a current of about 50 volts *each*, because of the danger to life of touching cables or wires carrying such powerful currents." We doubt even if the gentleman who figures so prominently in a well-known fable of the ancient Æsop could have rivalled his lordship in the art of blowing hot and cold with the same breath. It is evident, from a very cursory glance, that the paper is either inspired, or was penned when his grace was in a state of high tension, for the direct supply is completely put out of court. "We should have to use conductors," says the Duke of Marlborough, "of such size and weight that we could certainly not run them overhead; and, as to laying them underground, it is quite impossible in the narrow streets of London to provide trenches sufficiently large to hold the cables that would be required."

He is also perfectly confident that, "except for districts where the main current used is at least a 2,000 volt current it will be absolutely impossible to lay the wires underground in the narrow streets of the Metropolis."

He then, on the strength of his opinions, strenuously advises intending purchasers of electric light companies' stocks not to buy a single share till they have seen that the cables have been properly laid, and that they are of sufficient capacity to light the whole district which the company has undertaken to deal with.

What a chance here for "enterprising electricians," as our contemporary, *Inventions*, would say! The numbers of young men now out of employment could act as technical advisers to the speculators who wished to invest a £10 note in a single share of some poor electrical company's stock. Jocularity apart, however, we do think with the Duke of Marlborough that the electric lighting companies have not quite realised what underground wiring means in London; still, if everybody had taken a few years ago such extreme views concerning the complicated and hidden network of pipes beneath our streets, we should never have had an underground railway. If the Electric Lighting Act contemplates that electric light wires shall go underground it will be done, aristocratic authors to the contrary notwithstanding

We might call attention to other passages in the noble lord's rambling article, but it would serve no useful purpose, and we will therefore simply conclude by protesting against the publication of such papers as that to which we have drawn attention. Editors of society magazines might do worse than take unto themselves similar advice to that tendered by his lordship to the intending investor.

DR. J. A. FLEMING has designed an incandescent lamp slide rule, by which any of the calculations with regard to lamps may be performed with readiness. Thus if we have given the current, the terminal volts, and the candle-power, the scale shows the watts per candle; or given the watts per C.P. and the candle-power, we can find the current corresponding to any voltage; or from the volts and current we can read off the hot resistance; and finally, when we know the volts and current when the lamp is burning at normal brilliancy, the rule shows the approximate candle-power. We imagine that electric light engineers and their assistants will find this little device, which is issued by the Edison-Swan Company, very handy.

MR. F. B. BADT, who last year stayed amongst us for some weeks, has just published a little book modelled upon his previous works, the "Dynamo Tenders' Handbook," and the "Bell-hanger's Handbook," which met with much success. His latest effort, "Incandescent Wiring Handbook," we shall review fully in our next.

SO far from abandoning the electro-motor method of working the phonograph, we are informed by Col. Gouraud that Mr. Edison has perfected it to a degree beyond which improvement seems impossible. We hope to take an early opportunity of seeing the latest development.

IT is possible that electricity will not, after all, be used in America as a means of executing criminals, notwithstanding the passing of a law adopting its employment. So much has been recently said, for and against, during the recent enquiry in the States, that it seems there exists much uncertainty as to its efficacy. We see such statements as these:—"Two men have touched the same wire at the same time and place with very different results." . . . . "The shock which will kill one man may not kill another." "It is not at all certain that any machine can be procured which would generate an electric current of sufficient force to kill under all circumstances, &c., &c." The first two quotations may be taken for granted, and have for many years been common knowledge; but if there is one thing besides death and quarter day of which we make sure in this world, is that a dynamo can be constructed to send anybody into the next provided he is properly prepared.

ON another page may be found an extract from the *Canadian Gazette* of August 1st, showing the progress made in the Government survey of the Pacific cable route. The results so far may be looked on as very satisfactory, as they prove that on the section between New Zealand and Fiji (the only section yet surveyed by the *Egeria*), the bottom is quite regular, with an average depth of about 2,400 fathoms. The deep water referred to in the report is more than 500 miles to the eastward of the proposed cable route. The various shoals and "vigias" examined and reported on by the *Egeria* also lie well to the eastward of the route. and have little or no bearing on the question.

THE Executive Council of the Edinburgh International Exhibition of Electrical Engineering met on Wednesday. The title of the exhibition was unanimously fixed as "The International Exhibition of Electrical Engineering, General Inventions and Industries, 1890." Authority was given to the secretary, Mr. George E. Watson, C.A., to execute an agreement with Mr. Lee Bapty, of the Manchester International Exhibition, as general manager of the Electrical Exhibition. It was reported that the guarantee fund now reached £5,000. A deputation was appointed to endeavour to see Mr. Edison in London this week. Arrangements have been made to receive the exhibits of Mr. Edison, including those which are at present at the Paris Exhibition. It was decided that a special section of the exhibition should be devoted to electrical appliances of a scientific nature, such as are used in medicine and surgery.

COMPLAINTS are being made respecting the lighting of some of the underground railway stations. A correspondent of the *New York Herald* (London edition) says that the Royal Oak Station, being connected with the Great Western Railway, is electrically lighted, and therefore satisfactory, whereas at Victoria and the three Kensington stations the gas lamps are mockeries which grow dimmer as midnight approaches. This economical darkness, however, is not peculiar to the stations named.

THE Select Committee of the House of Lords appointed to enquire into the Bills confirming the London electric lighting orders on Wednesday passed the Bills confirming the whole of the orders granted by the Board of Trade, and subsequently confirmed by the House of Commons, with the exception of the Westminster order, which is still under consideration, and the South London order for the lighting of Clapham, Streatham, and St. Mary, Lambeth, which has been withdrawn. The Committee also passed the Bill promoted by the Metropolitan Electric Supply Company for the supply of electricity to that portion of St. Martin-in-the-Fields which lies to the east of Northumberland Avenue, Charing Cross, and St. Martin's Lane. The evidence given in this enquiry is reported at length in our other columns.

STANDARDISING ELECTRIC MEASURING APPARATUS.

Announcement of the Berlin Imperial Physico-Technical Office for Testing Electric Measuring Apparatus.

A.—Regulations.

The Second (technical) Department of the Imperial Physico-Technical Office undertakes to test the present values of electrical resistances and normal elements, as well as the indications of measuring instruments (current and potential) for continuous currents. The office reserves the right of examining the fitness and durability of such instruments prior to undertaking the ordinary tests.

The examination of electric appliances, other than those named above, will be undertaken by the Imperial office in as far as they present, in its judgment, a general interest, technical or scientific. As to the extent and the execution of such tests, a special agreement with the parties interested is requisite.

The testing of electrical measuring apparatus is carried out according to the following regulations, and a certificate can be given if desired. The issue of regulations concerning the examination of measuring instruments not mentioned here is reserved.

I.—*Resistances.*

Section I. An attestation with reference to the regulations in section 3; number 3 and section 5 is admissible only for single resistances and resistance boxes of platinum silver, nickel silver, and similar alloys whose conductivity is not affected by temperature more than that of the above-mentioned materials. Resistances of graphite, carbon and electrolytes are excluded from attestation.

Section II. The construction of resistances admitted as certifiable must conform to the following regulations:—

1. The plan and make must afford sufficient evidence of the certainty and invariability of the values.
2. Parts whose injury or arbitrary alteration is easily possible and not readily perceptible, must be enclosed in a substantial case, capable of removal when handed in, and of receiving the safety fastenings to be appended by the Imperial Office.
3. On every measuring instrument must be marked the name of the manufacturer and the trade number, or, in place of the name, an officially registered trade mark.
4. The value of the resistance must be plainly marked in ohms.

Section III. As it may be desired by the parties concerned, resistances can be tested and certified either as for common use, or for purposes of precision. Under the former class come:—

1. Resistances whose deviations from the normals of the office at + 15° centigrade do not exceed ± 0·005 of the alleged values.
2. As resistances of precision such whose deviation from the normals at + 15° do not exceed ± 0·001 of the alleged value.

In resistance boxes these limits of error must be adhered to both for single resistances and for combinations of several resistances.

The coefficients of temperature in resistances of precision must be supplied by the manufacturer. Only in cases of glass tubes filled with mercury, which may be certified as resistances of precision, the Imperial Office, if requested, undertakes to affix these marks and those required under section II., No. 4.

The examination of resistances for common use is effected by comparison at the mean temperature of a dwelling room; that of resistances of precision takes place at two different temperatures, suitably selected.

Section IV. The attestation takes place by applying a stamp and the number of the test near the stamp showing the value of the resistance, by attaching safety fastenings to the case and by drawing up a certificate. In resistance boxes the stamp is affixed near one of the mean values. The stamps and the fastenings bear the Imperial eagle and the date of the examination. On the stamp for resistances of precision there is also a star with five rays.

The accompanying certificate shows, for common resistances, their deviations from the standard instruments of the office up to ± 0·001, and for resistances of precision at two temperatures up to at least ± 0·0001 of their alleged values. In smaller resistances the deviations are indicated only up to 0·000001 ohm. The ohm is calculated as 1·06 Siemens units.

Section V. Resistances of stout copper ropes, which fulfil the conditions, section II., Nos. 1, 3 and 4, may be exceptionally admitted to examination. Such a resistance is tested at the temperature marked upon it, or if there is no such mark at 15° C., and if the deviation does not exceed ± 0·01 of the alleged value it may be stamped. In the accompanying certificate the limits of error and the weight of the resistance are stated.

II.—*Normal Elements.*

Section VI. For the present the only normal elements which can be tested and certified are those of Latimer Clark, marked as such, and so constructed that they may be inverted without the zinc coming in contact with the mercury. The requirements, section II., Nos. 1, 2 & 3, must also be observed. Any thermometers firmly attached to the normal elements must, prior to their insertion, have been submitted to the Imperial Office, and have been marked with its stamp.

Section VII. A normal element is tested by comparison with the standards at the office. If the discrepancy is not greater than ± 0·001 volt, the element, with due regard to the regulations, section IV., No. 1, may be stamped, and the accompanying certificate must show that the above limit of error has been observed.

III.—*Ammeters and Voltmeters.*

Section VIII. For the present, ammeters for strengths of current up to 1,000 ampères, and voltmeters for potentials up to 300 volts, are admissible for testing and attestation, if they conform to the regulations, section II., No. 1 to 3, and if the values of the graduated scale are plainly marked in ampères or in volts, as the case may be.

On measuring instruments whose guaranteed application is confined to one part of the scale, the limits of their applicability are to be marked as: "ammeter correct from . . . . to . . . . ampère, or voltmeter correct from . . . . to . . . . volts. The range of accuracy must extend to at least 10 degrees of the scale.

Section IX. An ammeter or a voltmeter is tested by comparison with the standards of the Imperial Office in at least three parts of the scale, both during a rise and a fall of the current or the potential.

In testing voltmeters which are plainly labelled as intended only for short or for prolonged use, the time of introduction is measured accordingly; in the former case at most a minute, and in the latter at least an hour. If the length of time for which a voltmeter is intended is not marked, the limits of error must be indicated both for short and for prolonged use.

Section X. The certificate is given for measuring instruments without limit of the range of applicability, if the errors found either do not exceed ± 0·2 of the degrees containing the point examined or immediately adjacent, or if they do not exceed ± 0·01 of the alleged value. In instruments with a limited applicability of the scale (section VIII., section II.) the error must not exceed ± 0·01 of the alleged value.

The stamping of an ammeter or a voltmeter takes place in accordance with the regulations section IV., section I.; the stamp is placed near the middle of the scale of applicability. Along with the stamped instrument there is given a certificate pointing out the existing errors.

IV.—*Fees.*

Section XI. The charges will be:—

1. For testing and stamping, *a*, of a single common resistance, 2s.; *b*, of a set of common resistances, 2s.,

and for each member of such a set in addition, 6d.; *c*, of resistances of precision four-fold the fees *a* or *b*; *d*, of a mercury resistance. 12s.

2. For testing and stamping a normal element, 1s. 6d.

3. For testing and stamping, *a*, an ammeter below 300 ampères or a voltmeter at three points of the scale, 3s. For testing every additional point ½s. *b*. An ammeter from 300 to 600 ampères 1½ times as much as for *a*. *c*. An ammeter from 600 to 1,000 ampères double *a*.

4. For subsequent references, 6d.

5. For testing measuring instruments which do not admit of legal stamping, according to time, the fee per hour is 1s. 6d. If the errors detected are communicated, the fees will be the same as for stamped articles.

6. Examination of the utility and durability of electric apparatus and appliances fees according to the time spent, and per hour, 3s.

Charlottenburg, May 24th, 1889. Imperial Physico-technical Office. (Signed) VON HELMHOLTZ.

B.—EXPLANATIONS TO THE FOREGOING REGULATIONS.

It is among the duties of the Imperial Physico-Technical Office to test electrical measuring instruments for technical purposes, and at the request of the parties concerned to furnish them with an official certificate. Such certificate should not merely guarantee their accuracy at the time of testing, but within certain limits their non-liability to variation. The attestation must, therefore, for the present, be confined to those few kinds of measuring instruments concerning which we have already extensive and prolonged observations. It is, however, intended in the sequel to admit other kinds of measuring instruments to official examination. This is remarked with an especial view to condensers and to ammeters and voltmeters for alternating currents. Electrical counters have hitherto not been stamped, because in their present form they cannot be officially secured. As soon as this is rendered possible the admission of these important instruments to the privilege of stamping will be taken into consideration.

For every kind of measuring instrument the accuracy and invariability of its indications must first be examined. If, therefore, instruments of any certain form, not previously admitted to certificate, are to be tested and certified, a request for a preliminary examination must first be handed in along with at least one of the instruments. In some cases apparatus which have been recognised as admissible for weak currents may be re-examined if they are to be used for currents of much greater strengths.

In addition the Imperial Office undertakes to test such measuring apparatus which, for the present, are not allowed to be stamped. Other electrical instruments and appliances may also be examined at request if they present any general interest.

The examination is effected in all cases by comparison with the standards of the Imperial Office. Their arrangement and the routine of the examinations will be described at length in the *Zeitschrift für Instrumentenkunde* and in the electrical journals. The accuracy of the standard resistances of the Imperial Office is ascertained by comparison with copies of the standards of other governments and with resistance units made by eminent physicists.

The office will endeavour to dispatch the measuring instruments handed in for examination in at most three weeks, reckoned from the day of receipt. But the completion of resistances of precision and of such ammeters and voltmeters in which there is fear that the indications may vary in time a delay of two months is generally required.

Under I.—The requirements of resistances admissible for stamping exclude sliding wire bridges and similar appliances, as their indications cannot be sufficiently guaranteed for any length of time. As regards accuracy and invariability, especial attention is given to strong leads and safe connections of the resistance wires.

In resistances of precision on heating to 50° C., the alleged resistance must not vary more than 0·00005 of its amount. The wires must be so secured that they may not be bent in use. It is also recommended to use coils of the largest possible diameter, and in wrapping the wire to avoid any considerable distortion of shape. The wrapping must be so arranged that the wire may quickly give off its heat to adjacent objects. Finally, it is recommended to make arrangements for introducing thermometers into the interior of the resistance, the more easily to ascertain the temperature of the wires.

Under II.—The mercury sulphate element of Latimer Clark is hitherto the only normal element made in a form suitable for transmission. Attestation may, however, in future be extended to other normal elements.

Under III.—The indicator works of the ammeters and voltmeters must not suffer any injury from shocks in the course of carriage or the sudden introduction of the current. The measuring instruments must also not be affected in any notable degree by external magnetic powers of moderate strength, such as are not easy to avoid in practice.

As the adjustment of the measuring apparatus for any given current or tension must be taken in general that position of the finger at which it comes to rest if not disturbed. At special request, however, that position of the finger is recognised in which it remains if it is checked with the hand and allowed to slowly move up or down on the scale. In this case it is specially noted on the certificate.

In voltmeters the introduction of the instrument in the circuit is extended to at least an hour at the mean potential of the range of the instrument, if marked on the scale. Otherwise it is introduced at that degree of potential at which the instrument is most sensitive, or, if there is a considerable range of equal sensitiveness, at its mean potential. In the certificate it is stated at what potential the prolonged introduction took place. If the party concerned wishes the instrument to be inserted at more than one potential, or if the Office thinks such a procedure necessary, special fees are chargeable.

Ammeters and voltmeters which are not capable of inclosure in a sealed case, in accordance with the regulation in section VIII., section II. and section III., cannot be stamped. Most such instruments—*e.g.*, the torsion-dynamometers and torsion-galvanometers hitherto in use have essentially maintained their character as measuring instruments. Those who work with such apparatus are generally so well acquainted with electric measurements as to test their indications by means of resistances, normal elements or voltameters. If anyone desires the examination of such instruments in accordance with section II. of the introduction, it will be undertaken by the office by special arrangement.

Under IV.—When the fees are calculated according to time, a small charge is made for current tests carried out by technical assistants under inspection. For determinations which have to be executed by the scientific officials of the Imperial Office, a higher scale per hour is charged.—*Elektrotechnische Zeitschrift.*

ON ACTINO-ELECTRIC PHENOMENA.

Note by M. A. STOLETOW, presented by M. MASCART.

THANKS to some improvements in the conditions of the researches, I have succeeded in studying more fully the laws of actino-electric currents in the air with ordinary pressure, sketched out in my first note on the subject.*

In order to obtain numerical comparisons with some degree of accuracy I have recourse to a simultaneous controlling apparatus, which enables us to eliminate the inevitable and rapid changes that the electric arc undergoes. In front of the principal condenser, in which we can vary either the distance of the armatures or the electromotive force, I place a second, in the form of a cross, which falls within the same cluster of rays, and remains under constant conditions. Two galvanometers of the same period are connected with these two condensers, and on opening the screen of the lantern two observers note the simultaneous elongations in the two circuits.

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* *Comptes Rendus*, vol. cvi., p. 1,149; 1888.

1. Under these conditions the two elongations remain in good proportions, when the electric arc is varied, without changing anything else, provided that the experiment does not last too long. Little by little the condenser which is nearest to the arc becomes exhausted quicker than the other, and the ratio of the sensibilities varies.

This proportion of the effects in two different apparatus is somewhat remarkable in itself. We see that, all else being equal, the actino-electric current is *in proportion to the intensity of the active rays.*

I verified this conclusion by another experiment. A large disc of carboard, cut so as to present 16 equal sectors, alternately full and empty, is placed vertically between the lantern and the principal condenser and put in uniform rotation with different speeds. We find that the current observed is always precisely the half of that which is obtained by taking away the cardboard.

2. I have undertaken a long series of observations in order to study better the influence of the distance, l, of the armatures, and of the electromotive force, E, and I arrive at a very simple result. When we vary l (from 2 to 50 millimetres) and E (from 1 to 100 L. Clark), but keep the ratio $\frac{E}{l}$ constant, the effect does not change; the current is then a function of $\frac{E}{l}$. In other words, the current is a function of the electric density of the negative armature, or of the electrical force acting at the surface of this armature.

The curve, which represents the intensity of the current as a function of the electrical force reminds us of that followed by the magnetic momentum of a long bar (or of a ring) of soft iron, when the magnetising force is varied. As long as the force remains small, the effect increases more rapidly than this force, then there is a point of inflection, after which the effect increases more and more slowly. This law is more general than those I gave in my first note (2 and 3) for special conditions.

3. I took great pains to decide whether the actino-electric current is established in a practically instantaneous manner, or whether it requires an appreciable time to attain its definitive value.

A commutator is fixed on the axis of the cardboard disc described above. When the disc turns, the principal circuit is closed alternately by the galvanometer and by an auxiliary resistance, the commutations following at equal intervals, 16 times in each revolution. Under these conditions the galvanometer must consume a certain fraction more or less great of the total current. Let us suppose that the total eclipse of the condenser only lasts an instant, and that the galvanometer re-enters the circuit just at the moment of the first quarter, to leave it at the moment of the last quarter; we shall then have in the galvanometer ·394 of the total current. By displacing the commutator this fraction may be diminished to ·106 (the minimum).

Now, while the commutator remains at the maximum but the speed of rotation be increased more and more, if the actino-electric action takes some time to establish itself, we shall obtain weaker and weaker currents, as if the commutator were displaced in less and less advantageous positions. If the current observed does not change, we must conclude that it is established instantaneously.

In these experiments it is very difficult to get rid of certain electrical effects due to friction in the revolving commutator. When we take care to eliminate them, we arrive at the conclusion that the delay of the current does not exceed $\frac{1}{1000}$th of a second.

I made some experiments to study the influence of the temperature. A platinum condenser, placed in an air bath, was heated little by little to 200° C. and higher. Unlike the results of M. Hoor,[*] I find that the actino-electric effect is not suppressed by heating; it really becomes more powerful, but the progress of the phenomenon is somewhat complicated, and presents secondary maxima and minima. I repeated another experiment of the same writer's, and this time also with a negative result. A disc of metal which remained for 24 hours under a glass gummed at the edges undergoes no marked diminution of actino-electric sensibility, provided that the metal and the glass are both quite clean and perfectly dry.

I think, therefore, that the hypothesis which attributes the actino-electric phenomena to the layers of condensed gas that cover the metallic surfaces must be rejected. The extreme sensibility of fuchsine, of aniline green and violet, either in a solid form or in solution, a sensibility which, according to my recent observations, far surpasses that of metals, seems to confirm my opinion.

ON CONTACT ELECTROMOTIVE FORCE.[†]

Note by M. N. PILTSCHIKOFF.

IT is well known that the magnitude of the difference of potential which is produced at the contact of any two bodies whatever is a function of two variable conditions: (1) the chemical nature of the bodies; (2) the physical condition of their superficial strata. Thus we can easily explain the discrepancy, often considerable, between the results obtained by different very clever experimentalists. In fact, whatever pains we may take to eliminate the various sources of error in our observations, we can never render the structure, and more generally the physical condition of the superficial strata, identical in the various experiments. Let us take the case of gold and zinc, their contact electromotive force, which can be determined without much trouble to about $\frac{1}{1000}$th of a volt, may change in value as much as $\frac{1}{4}$ of a volt, according to the physical condition of the surface of the zinc.

We might obtain results more in accordance with one another by studying the contact of liquid metals by means of their amalgams; but we should not be justified in extending the results obtained by this method to the case of the contact of solid metals. Moreover, we are not interested in obtaining agreement; on the contrary, it is the examination of the different results which offers great interest in the study of the various molecular conditions of bodies.

Here is, for example, a case that has not yet been taken into consideration. Let us consider any two metals whatever. The heat of substitution of one metal for another is not, in general, the same for different chemical combinations; a metal, liberated from its various salts, possesses different molecular energies. Might not the study of the correlation which should exist between the contact electromotive force of metals considered under these different molecular conditions and their other physical properties have considerable bearing on the theory of contact?

Let us now pass to another point in this theory. The contact electromotive force is considered independently of the extent of the surfaces in contact. Is this strictly accurate? Let us consider two surfaces, A and B, by which any two bodies touch one another. Whatever homogeneousness these surfaces may possess, this homogeneousness is not absolute; it follows that the contact electromotive force is not absolutely constant at all points of the surfaces under consideration. Let us then give to the surface in contact sufficiently small dimensions, and we shall be able to measure an elementary difference of potential, in general different from the mean value. From the above considerations we may draw several fresh conclusions. Here are two :

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[*] *Sitzmys berichte d. Wiener Akad.* Abth IIa, Bd. XCVII., p. 719; 1888. *Comptes Rendus*, 1st half-year (Vol. VIII., No. 24.)

[†] *Comptes Rendus.*

1. The contact electromotive force, taken on a vertex or ridge, or on one surface of a crystal, has different values.

2. If one of the surfaces is not isotropic ; if there exists, for example, a single axis in relation to which the different physical properties of this body are distributed symmetrically, the electromotive force of contact with a second body (always supposing it to be the same) will also be distributed symmetrically in relation to the same axis.

In order to demonstrate experimentally the inequality of the elementary electromotive forces at the various points of a physical surface, I use the following method :

Let us again consider two surfaces, A and B, and let A be the surface of the metal, and B that of an electrolyte (a solution of another metal). On applying to these two surfaces an external electromotive force, E, we follow in a microscope the commencement of the formation, on the metallic surface, A, of a deposit of the metal contained in the electrolyte. How is this deposit formed ?

It is easy to see that, if the electromotive force at all the points of contact in the surfaces, A and B, is absolutely constant, the deposit will take the form of a layer, the thickness of which will be at each point of the cathode in a known relation with the resistance met with by the current passing through the electrolyte. If, on the contrary, the various points of the surface, A, possess different electromotive forces, we shall see the deposit commence at a single point, for which the elementary current will have the maximum intensity. All the other points of the surface, A, will be covered by the deposit in the order of the value of the corresponding elementary currents. Now, as in this case the intensity of the elementary currents will depend on two independent variable conditions, these points will no longer be distributed regularly over the surface, A.

Experiment always shows the last mode of development of an electrolytic deposit.

By regulating the progress of the phenomenon, it is easy to vary the time that elapses between the appearance of the successive points of the deposit from a fraction of a second to several minutes. On changing the sign of the external electromotive force, E, applied to the surfaces, A and B, we find that within a few thousandths the time necessary to dissolve a deposit by the current is equal to the time that was required to form it. We may make sure that the points of formation of the initial deposit are not due to accidental impurities on the surface, A, by washing it with acids, which does not affect the part played by these points in the development of the deposit, as may be verified by repeating the experiment, and observing the relative positions of these points in relation to the micrometer of the microscope.

If the surface, A, presents striæ, or if it is limited by ridges immersed in the electrolyte, we see the deposit appear principally on the striæ and on the ridges, a phenomenon known for some time. The above theory accounts for this fact, which up to now has been unexplained.*

CONTINENTAL ITEMS.

By an agreement dated May 27th, 1889, a new limited company has been formed in Paris under the name of Société Anonyme d'Eclairage Electrique Départmental. It has been formed by the members of the Levallois-Perret Electric Lighting Company, and its objects are as follows :—1. The lighting by electricity of edifices, houses, establishments, public thoroughfares, &c., of the departments, towns, and communes of France. 2. The creation, patronage, acquisition, and the supplying of funds to departmental or communal electric lighting companies and similar ones, as the fusion with all other companies in working or in course of formation. Its duration is 30 years, dating from the day of its definite constitution. The office to be at Levallois-Perret (Seine), rue Poccard 31. The first directors are as follows :—MM. Faullain de Banville, electrical engineer ; Paul Berneau ; de Bigault de Maisonneuve ; Ernest Goblet, engineer ; and Bousquet-Deschamps.

Experiments have just been made on the line of railway running from Valéry to Cayeux with an apparatus for corresponding telephonically by means of the telegraph wires. This apparatus, which is the invention of M. Mauborgne, is intended to place a train which has broken down in communication with neighbouring stations. It consists of a wooden box, 30 centimètres high by 30 centimètres in width and 20 centimètres deep, weighing 10 kilogrammes, containing a telephone, a microphone, two contact pieces, a trembling bell, a two-direction commutator, and some battery cells. One of the ends is joined to a telegraph wire by a flexible conductor, and the other to a rail, the call button is pressed, and when an answer is received, the commutator is turned in order to connect the receivers on the lines. It is sufficient, on account of the electromotive force of the battery, to have a fixed telephone wire every 40 kilomètres.

The City of Brussels continues to receive tenders for the electric lighting of its streets, public places, promenades, theatres, and monuments. In connection with this complete project of electric lighting, and the establishment of a central station for the supply of motive power, it is interesting to recall the project of last year. This project embraced the lighting of the Parc, the theatre of that name and its dependencies, of the Cercle Artistique, of the Ministries, and of a part of the Notre Dame aux Neiges quarter, of the Royal Circus, the Eden Theatre, and the houses and public establishments of the Rue Royale and the Place Royale. The authors of this project obtained from the Collège permission to instal the necessary machinery to produce the motive power in the small building used for housing a portion of the stage decorations of the Parc Theatre. They designed several innovations, such as protecting the cables by small masonry sewers, a system which is in use for the protection of the Parc gas mains, and now adopted in France. All was ready ; plans, calculations and everything, when the Municipal Council decided to considerably extend the project, and to ask private companies for tenders.

The Paris Municipal Council met for a short session on Wednesday last week. Among other points they have to consider is the question of electric lighting, which, judging from previous experiences, is likely to lead to some lively scenes.

NOTES ON THE DYNAMOS AT THE PARIS EXHIBITION.

IV.

The dynamos exhibited by Mons. Joseph Jaspar, of Liège, next claim our attention. Two types are shown, having respectively four and two poles, as illustrated in figs. 1 and 2. The machine, fig. 1, gives at a speed of 700 revolutions per minute a current of 230 ampères at a difference of potentials of 70 volts. It is compound wound to supply current simultaneously for incandescence lamps and arc lamps in parallel. The octagonal yoke ring and radial magnets are of cast iron, all being in one piece. The armature ring is made of iron wire, and has a diameter outside of 376 mm. with an interior opening of 270 mm. Its length is 360 mm., and it is wound with 135 lbs. of insulated copper wire 4·2 mm. diameter, two wires being wound in parallel and the coils coupled up to a 120-part commutator. The current is collected by four sets of brushes. The resistance of the armature is ·0085$^{\omega}$ hot. The cast iron magnets weigh 1,646 lbs. They have on their coils 93 lbs. of series wire 5 mm. diameter coupled eight wires in parallel, and 330 lbs. of shunt wire 3·1 mm. diameter. The series coils have a resistance hot of ·0032 ohm, and the shunt coils a resistance hot of 5·75 ohms. The total weight of copper as above is 558 lbs., the total weight of the machine being 4,092 lbs. Its electrical efficiency is 92 per cent., the resistances being taken when the machine has attained its working temperature.

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* These experiments were made at the Laboratory of Physical Research at the Sorbonne.

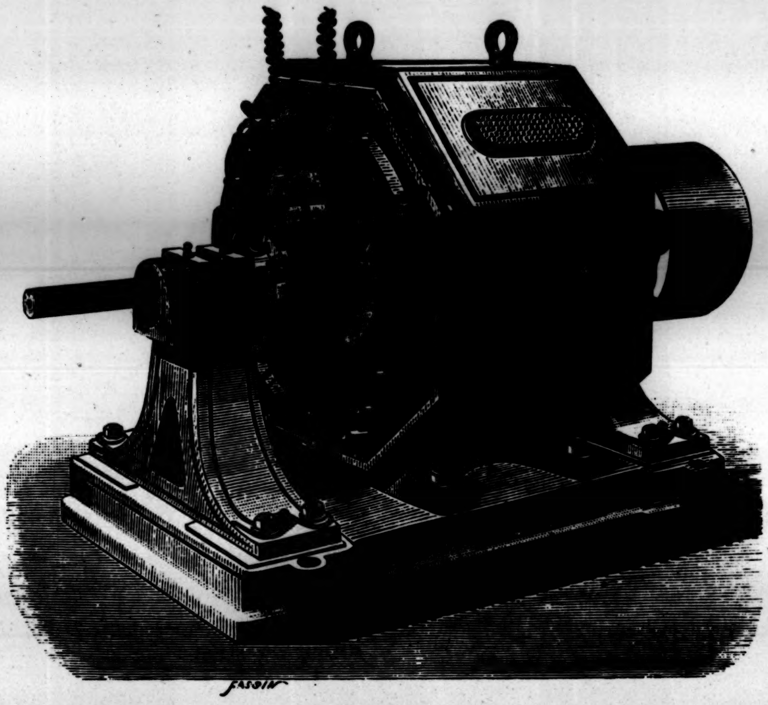

FIG. 1.

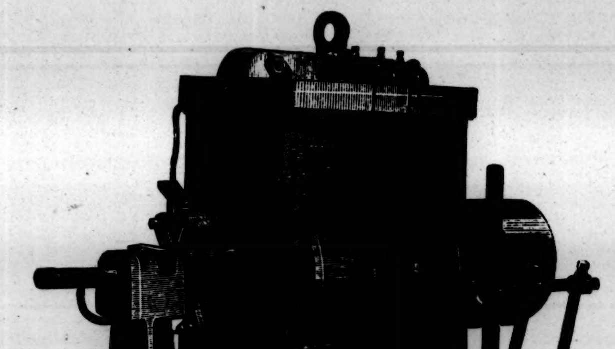

FIG. 2.

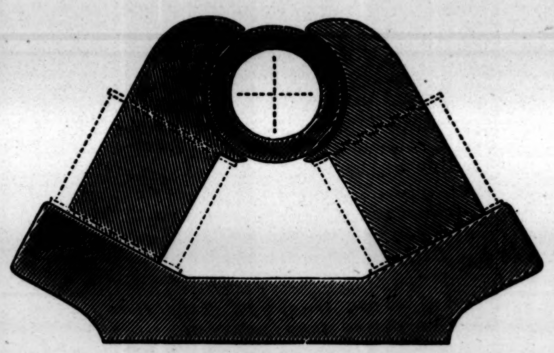

FIG. 3.

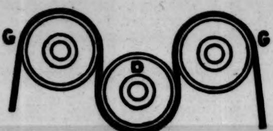

FIG. 4.

The dynamo, fig. 2, of the two-pole type, has also its magnets constructed of cast iron. This configuration is doubtless familiar to our readers, and the machine, though substantially made and a good specimen of its class, calls for no special description.

Another exhibitor from Liège is Mons. H. Pieper. At his stand we noticed a dynamo of the single horseshoe inverted form with a Gramme wound armature. A sketch of the field magnets of this machine is given in fig. 3, and it will be observed that the limbs, which are of circular section, spread out at the base instead of standing up parallel to each other. It is probable that the object in adopting this design is to ensure that the lines of the field divide more equally between the two halves of the ring armature than they do when the magnet limbs stand parallel to each other. By its adoption the magnetic circuit is somewhat lengthened, though not to the extent observable in machines in which the magnet limbs lie in line opposite each other, and are connected with a split yoke as in fig. 4 of our first article (page 37). In these latter we have a perfectly symmetrical field, but with a long magnetic circuit, and a necessarily heavy yoke. The present type may therefore be regarded as a compromise in which the induction circuit is not so long nor the frame so heavy, but where on the other hand the field is less symmetrical, though more symmetrical than in machines of the single magnet type with a still shorter circuit and less weighty magnets.

Several machines of the four-pole disc type, designed by Mons. Julien Dulait, are exhibited by the Compagnie Electricité-Hydraulique, of Charleroy, Belgium. These closely resemble the Victoria machine, as made some years ago, with narrow pole pieces. The commutator segments are cross connected, and the current collected by two brushes 90° apart. Some of these machines are combined with vertical steam engines, being mounted on a platform above the flywheel and driven by a short belt which passes over guide pulleys, G, G, which, as shown in fig. 4, are placed on each side of the machine pulley, D.

(*To be continued.*)

LIGHTNING CONDUCTORS.

By S. ALFRED VARLEY.

(*Continued from page* 79.)

SINCE the issue of the last portion of this article I have had the advantage of a conversation with Mr. Wimshurst, and I find the explanation I gave as to the source of the B spark requires modification. (See ELECTRICAL REVIEW, July 19th, fig. 4.)

The B spark appears to arise solely from a prolongation of the current in the conductor, L, after the Leyden jar discharge has passed through it (it is simply a repetition in the laboratory of what was recorded by me as having occurred in 1856, when lightning discharged itself through a telegraph circuit), the discharge of the accumulated electricity involves overcoming the inertia of the path of discharge, L, and the overcoming this inertia means a storing up of energy in the shape of active magnetism in the conductor. This storage of energy involves time, and it is the time taken up in such storage which determines the duration of the act of a statical discharge, and therefore I was in error, in saying as I did, in the issue of July 19th, that the Leyden jar discharge occurred in a less time when the B knobs of the alternative path experiment were approached near enough to one another for the B spark to be developed. The error arose from a misunderstanding (corrected by conversation with Mr. Wimshurst) which led me to conclude the B spark took place at the same time as the discharge through the metal path, L, and between the A knobs of the two Leyden jars instead of its occurring afterwards.

In the alternative path experiment, due to Prof. Lodge, in which the distinguishing feature is what he has termed the B spark, and which has been referred to above, so soon as discharge has taken place through the metal path, L, this conductor commences to reassume its normal unmagnetic condition, and the stored up energy which developed the magnetic polarisation dissipates itself by producing a current which flows *through the conductor*, L, in the same direction as that from the Leyden jars, and which is of so high a potential, that it bridges a space of air when the two ends of the wire loop approach sufficiently near to one another, and so forms the B spark.

Mr. Wimshurst, who has repeated the experiment in various ways, finds the air space capable of being bridged greatest when the path, L, is in the form of a circle, and that it becomes very much reduced when the wire forming this path is bent back upon itself so as to produce a long U, the two limbs of which are in close proximity to one another.

The reason the B spark becomes reduced when the path, L, is arranged in the form of a long U seems obvious enough, the magnetic polarisation of the one limb opposes that of the other, and therefore there is not so great a storage of energy in the conductor, consequently the potential of the B spark is correspondingly less; incidentally, also, such disposition of the conductor favours the accumulation of statical charge between the outer surfaces of the two limbs; this also tends to reduce the potential by a temporary lateral diversion of energy.

There is a question which occurs whilst writing which is put forward only suggestively, and that is what influence has the arranging the wire of the L path, in the form of a long narrow loop, on the duration of the act of discharge. If there be a given amount of energy stored up as statical charge, when discharge occurs, this energy becomes dissipated, and we may be sure a definite amount of work is performed by such dissipation, whatever be the disposition or nature of the path of discharge. Now discharge through a conductor would appear to involve a breaking down and reformation of the atomic constitution of the molecules producing internal motion evidenced by the development of magnetic polarisation, and the rate at which this occurs determines the potential of the active magnetism developed in the conductor during the whole time an electric discharge or current is passing through, and therefore when the disposition of a path of discharge is such that one half of the path opposes the magnetic polarisation of the other half, it would seem to follow that the act of a Leyden jar discharge through it would be prolonged, and that therefore less noise should be produced by a discharge through a zigzagged conductor than through a similar conductor in the form of a circular loop. It must not be overlooked, however, a zigzagged conductor would favour a temporary accumulation of statical charge between the surfaces facing one another, and if the total surface of the zigzagged conductor were large, a Leyden jar discharge would rush into it in the same way as if discharged into a large uncharged Leyden jar, and therefore to test whether resistance opposed to magnetic polarisation lengthens the act of a discharge, the zigzagged conductor should be a long narrow strip.

If it be admitted the B spark is produced by energy stored up in the conductor during the act of discharge, and I think this can now be scarcely doubted, then it follows a Leyden jar discharge passes through the mass of the conductor, and is not confined to the exterior only, otherwise magnetisation of the conductor would not occur. The magnetism so developed is evidently of considerable potential; were it not so, the B spark would not be capable of leaping a space of air; but grant, for the sake of argument, the discharge is confined to the exterior of a conductor penetrating to a small depth only, as our mathematical physicists assure us it does, then when conductors of larger diameter are employed, the current should penetrate to a still smaller degree, and encounter less, *certainly not* more, magnetic inertia, and consequently the B spark ought to become weaker as the sectional area of the path, L, is increased.

Prof. Lodge's recorded experiments demonstrate this is not so; that, on the contrary, a larger conductor develops a more powerful B spark. In certain experiments described in the Dr. Mann lectures * with two copper wires of equal length, but varying sectional area, when the L path was formed of the heavier conductor whose sectional area was 109 times greater than that of the other, the B spark of the larger wire = 14·3, and that produced by the wire of smaller section = 13·4.

Now, for reasons given in an earlier portion of this article, I venture to think the B spark of the larger wire was both heavier as well as of higher potential than that of the wire of smaller section; and if this surmise be correct, then it follows more magnetism must have been developed in the heavier conductor, and such increase of magnetism demonstrates conclusively that more matter came under the influence of the Leyden jar discharge.

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* See "Society of Arts Journal," June 22nd, 1888, page 882.

I think it may be therefore fairly claimed Prof. Lodge's own recorded experiments afford *primâ facie* evidence that statical discharges pass through the mass of a conductor much in the same way as steady, continuous currents are admitted to do. I myself think it may be argued that steady voltaic currents and also statical discharges travel, *theoretically*, more rapidly through the central portion of a conductor, for, as a consequence of statical induction, there is a diversion of energy laterally to a minute extent between the electricity passing through a conductor and neighbouring conducting matter which is greater in the immediate neighbourhood of the outer periphery than at the central portion of the conductor, and therefore energy would be expected to travel more slowly along the outer skin.

In reference to those phenomena, on which so much stress has been laid by Prof. Lodge in his Dr. Mann lectures, magnetic inertia has a very important bearing. In the dynamo machine magnetic inertia, as well as other electro-magnetic phenomena, are exalted to the highest degree; such machines, therefore, afford special facilities for scientific study; everything in this world is so intimately related to everything else that the different divisions of science must be studied more or less together. It is, indeed, only by regarding the physical sciences as one great whole, and observing the phenomena presented to our gaze from every point of view that we can hope to obtain an approach even to an understanding of the mysteries amongst which we live and move. This is in a special manner true of electricity, the study of which, perhaps, more than that of any other division of science, brings us face to face with energy, the principle or centre around which all the physical sciences may be said to revolve, for all operations of nature involve motion, and all motion involves a transmission of energy.

In the immediate continuation of this article it is proposed to make a few passing remarks on the harmony which exists throughout those operations in which a transmission of energy is more immediately concerned; after this I purpose saying a few words on the nature of electricity, self-induction, and magnetic inertia, and then I shall endeavour to show how common sense reasoning on observed facts and established laws leads, step by step, to the conclusion that when energy is transmitted by rapid electric alternations, the currents set up in the central portion of the conductor are of higher potential than in the neighbourhood of the outer skin; and if this contention can be successfully demonstrated, then it follows that lightning discharges pass through the whole body of a lightning conductor instead of confining themseves practically to the outer periphery, which Prof. Lodge can now fairly claim to be the orthodox theory of our mathematical physicists.

If it be granted the operations of Nature harmonise one with the other, then we have a sure guide in the legitimate use of analogy; but analogies must be used intelligently, for example, when studying the principles underlying the transmission of energy; if we seek the assistance of analogy, the vehicle of transmission itself, and also the source of the energy, must be taken into consideration; care must be also exercised not to confuse the medium or vehicle of transmission with the energy transmitted.

A moving mass of people and a flowing river are examples of a transmission of energy, and they harmonise so far that the percentage of energy transmitted is greater in the centre than at the sides. In this simple observation, if there be the intelligence to perceive it, we may detect, I think, a central principle which governs the transmission of energy generally; but at the same time a theory of the nature of water, and how to control it, if formed only from observing and studying the movements of a crowd, would help us forward a little, but *only* a little way; for instance, a barrier which would effectually arrest the progressive motion of human beings could be constructed that would not perceptibly interfere with the motion of a stream of water; secondly, the energy of a moving crowd is under the control of the individual units who, acting more or less independently, do not move in unison, and consequently there is a large waste of energy dissipated in the form of heat.

Now when water is passing from a higher to a lower level, the energy arises out of the attraction of gravity, which acts equally and uniformly on the individual molecules which compose the stream: they therefore move together like a disciplined army, and consequently they do not jostle against one another, and a larger percentage of the energy associated with the water is transmitted than in the case of a moving crowd.

The general principles that govern the transmission of energy by means of electricity may be said, I think, to harmonise absolutely with what is observed in its transmission hydraulically, but regarded as an entity of some kind. Electricity is as much more subtle than water, as water or any other known liquid is than a moving mass of people treated as a fluid.*

In the transmission of energy hydraulically there is a loss of useful energy arising out of the fact that the energy has to move the vehicle of its transmission bodily, and this general law would seem to prevail in all cases, viz., the higher the potential, *i.e.*, the greater the amount of energy to the weight of its vehicle, the more complete is the transmission.

As an example of what seems to be a general law, consider the transmission of energy mechanically by means of a long wire passing over pulleys and moved rapidly in alternate directions, the overcoming the inertia of the wire and the pulleys, and the friction encountered, will consume energy. Let it be assumed the waste from the above causes equals 50 per cent. of the energy, if the wire and the pulleys can be reduced to half their weight, the inertia and the friction will be correspondingly reduced, and 75 per cent. instead of 50 per cent. would be transmitted.

The same general principle to that above, mentioned in reference to the transmission of energy by means of a wire, holds good with hydraulic transmission, and also with steam engines.

When energy is transmitted to a distance hydraulically the greater the amount of energy associated with the water moved—in other words, the higher the potential or pressure employed the greater the percentage of energy transmitted and developed as work at the distant station.

In a steam engine the available energy is determined by the difference between the extremes of temperature of the steam where it enters and where it leaves the engine. The higher the temperature the lighter the vehicle and the greater the amount of energy associated with a given weight of water. The greater the heat the larger the amount of energy which is capable of being converted into mechanical force, and in a well constructed engine the colder the steam where it leaves the cylinders the greater has been the conversion of heat energy into useful work.

Electricity as a vehicle of energy is theoretically much more perfect than water, for it has no weight, and when it is employed to transmit energy there is no bodily motion of matter involved; but when due allowance is made for the fact that electrical transmission of energy does not involve the moving of matter, then it will be found to harmonise most completely with what is observed in hydraulic transmission.

In the resistance all electrical conductors oppose, will be found the analogue of the skin resistance of hydraulic systems; inertia is also encountered, time being required to set up a transmission of energy either electrically or hydraulically, and time also is required to arrest electrical as well as hydraulic transmission after it has been set up. The B spark of Prof. Lodge's alternative spark experiment is a case in point.

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* Matter of some kind is the only thing the human mind seems to be able to grasp, and our acquaintance with matter arises out of familiarity with it much more than from knowledge of its nature; and therefore when dealing with electricity an image of some kind, taking more or less of a concrete shape, becomes necessary, and hence the terms electric fluid, electric currents, and motion of electricity employed; but, in the true sense of the term, there is reason to believe there is no such thing as an electric fluid or an electric current.

The fact that electrical motion or the production of an electric current, as it is more commonly termed, is not a movement of matter, but an internal motion setting up a state of stress in all the molecules of a conductor at one and the same time, and the fact that when such motion is being arrested the break may be said to be applied to each individual molecule at one and the same moment, explains how it is electric motion can be set up, arrested, and its direction reversed so rapidly. Whatever time is required for arresting and reversing the direction of electrical motion would appear to be solely due to the fact that the magnetisation, and also the demagnetisation of matter, involves the element of time. Time seems to be a connecting link between the forces, and also a determining cause when a conversion of energy occurs as to the particular protean shape into which it is converted.* The principle of continuity appears to run through all things, each advance possessing certain distinguishing properties in addition to that immediately behind it. Electricity stands undoubtedly at the head of the forces of nature, and, as a vehicle for the transmission of energy, it possesses all the valuable properties of other vehicles which are employed, and, in addition to these properties, it possesses also special qualities which render it theoretically a much more perfect medium than any other vehicle for the transmission of energy.

In what has been stated above, we have the explanation of how it is energy can be economically transmitted by electric alternations. It is true the resistance conductors oppose to rapid electrical alternations is very great, but such resistance involves no loss of energy *theoretically*, for overcoming inertia is a storing up of energy, and as energy is indestructible, all energy stored up is given back again, and in the case of electrical transmission of energy, it is given back in a useful form.

The following experiment will help to explain what has been stated above. Complete the circuit of a galvanic battery through a helix of insulated wire surrounding an iron core and include a galvanometer in the circuit. At the moment the circuit is closed the magnetic inertia of the iron core almost completely checks, chemical action being set up in the galvanic battery, and energy is set free by chemical action in the battery, at first very slowly; this is indicated by the galvanometer needle being first slowly, and afterwards more rapidly deflected. The energy set free in the battery gradually overcomes the magnetic inertia, and the equivalent of the energy expended in overcoming this inertia becomes stored up in the shape of active magnetism developed in the iron core. So soon as magnetic inertia has been overcome equivalent to the potential of the current the galvanic battery is capable of permanently maintaining through the helix, the current flows through the circuit and chemical action proceeds in the battery at the same rate as if there were no iron core inside the helix. Divide the circuit suddenly and the iron core rapidly reassumes its normal condition, and during the act of demagnetisation gives back the stored up energy by developing a temporary electric current which forms an arc across the air space where the circuit is divided; this arc completes the circuit during the time occupied by the iron core in becoming demagnetised, and the deflection of the galvanometer needle and also the chemical action in the battery is momentarily increased by the stored-up energy in the iron core, parted with in the act of its reassuming the normal unmagnetic condition. This momentary development of an electric current of high potential when the circuit of an electro-magnet is broken, and which produces a brilliant spark, is well known to all electricians, and is identical with the B spark of the alternative path experiment.

It may be convenient at this place to refer to a practical difference between transmitting energy by means of galvanic batteries and the transmission of energy by dynamos, which I am not aware attention has ever been directed to.

A galvanic battery is a reservoir containing a given amount of energy of position capable of being readily converted into kinetic energy.

When galvanic batteries are employed, the rate at which energy of position is converted into kinetic energy becomes checked whenever inertia has to be overcome, such as that which is met with in the case of the transmission of rapid electric alternations. In the dynamo, the inertia opposed by conductors to arresting and changing the direction of electric motion is balanced by the inertia of matter in motion. In the flywheel of the steam engine we have a storage of energy which overcomes temporary intermittent increases of resistance, and there is a considerable margin of energy usually in the boiler of the steam engine, which becomes automatically brought into play when a steady increase of resistance is opposed to motion in the dynamo. There is therefore a greater elasticity in the dynamo than in a galvanic battery, and as an agent for the transmission of energy, the dynamo is much more perfect, for the reason that it deals more directly with energy and motion than is the case when electric motion is set up by the more complex process of chemical reaction.

(*To be continued.*)

THE BRUSH CONVERTER SYSTEM OF DISTRIBUTION.

AMONGST others who have recently designed apparatus for the converter system of distribution is the Brush Electric Company of America, whose alternating current dynamo and converter we now proceed to describe.

The machine chosen for illustration in fig. 1 is constructed for an output of 60,000 watts at a difference of potentials of 2,000 volts. The speed is 1,100 revolutions per minute, which gives 110 complete induction cycles per second. This machine has a stationary coreless armature with revolving field magnets, and presents several new features as contrasted with existing machines. The bearing standards, base plate and slides for the armature are all cast in one piece. A shaft 4 inches in diameter, turned down to 3½ inches at the bearings, carries two heavy cast iron yoke pieces, 27 inches in diameter, on each of which are fixed in a circle 12 wrought iron magnet cores wound with insulated copper wire, and having their poles on opposite sides of the armature, facing each other. These magnets are arranged circumferentially in alternate polarity, the facing poles being of opposite name. The weight of the field magnets is rather over 1,700 lbs., the cores weighing 308 lbs., and the weight of copper wire on them being 400 lbs. The bearings are made of extra length, being 14 inches long at the pulley end and 12 inches at the other end.

The most interesting part of the alternator is the fixed armature, which has only six coils, arranged so that the space between them, measured circumferentially, is equal to the circumferential width of the opening in the middle of each coil. It will be seen that this arrangement gives an electrical result similar to that which would be obtained from 12 coils of half the convolutions placed close together, while securing at the same time the mechanical advantage of fewer parts. The coils are of insulated copper ribbon wound on porcelain cores, as shown in fig. 2. Each coil has on both its sides a wing of strong insulating material of the same thickness as the porcelain core, one of these wings being tongued on the edge and the other grooved. The coil, consisting thus of core, ribbon and wings, has an angular width of 60°. The upper part of each face of the coil is covered with an insulating plate $\frac{5}{16}$ths of an inch thick. The coil thus built up and insulated is set in German silver holders, cut from true turned rings and held together by screws, as shown in fig 2. Each terminal of the copper ribbon connects with a binding post, as shown. The six armature coils thus mounted are carried in a German silver frame consisting of two semi-circles bolted together on the line of the vertical diameter. The cross-section of this ring frame is girder-like. Into the slots of the frame slip the six mounted armature coils, the tongue on the edge of the one engaging with the groove on the edge of the next. The coils thus thrust into an intense magnetic field constitute a disc, $\frac{9}{16}$ths of an inch in thickness, with an opening in the centre through which passes the revolving shaft.

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* The bearing time appears to have in connection with what is termed a conversion of energy was treated at some length in an article by the writer, published in 1888 in the ELECTRICAL REVIEW.

The several coils are insulated carefully, and the stationary armature, as a whole, is insulated from the bed plate on which it rests. The coils are joined in series, the binding posts adjacent to any radial line of division between the two coils constituting fixed terminals for the main line. The resistance is very low. There is no commutator; there are no collecting brushes to take the alternating current from the rotating parts.

If a coil meet with accident it may be removed and a new one put in its place in three minutes, or the injured coil may be cut out of circuit and the dynamo kept running with the other five until the time for shutting down. The coil section complete weighs only about 20 lbs. The whole armature may be removed by loosening the coupling bolts and sliding each half of the frame with its three coils from between the field magnets. As each half with its coils weighs only about 100 lbs. no time need be wasted on cranes or blocks, and in a few minutes the armature may be back in position.

In action the 24 field magnets of the alternator are excited by the direct current from a 11-inch Brush dynamo of the well-known form. This exciting current is carried to the brushes that rest upon the two insulating rings (shown at the left of fig. 1); and thence through the hollow shaft to the magnets. A rheostat worked by hand or automatically is placed in the shunt circuit of the exciter, so that perfect regulation is secured without readjustment of the brushes or any necessity of handling the high tension current.

The fall of potential in the machine from no load to full load is less than 10 per cent., a result which has not been exceeded by any alternator with iron in its armature. All the regulation needed is applied at the exciter as already described.

In the Brush Company's converter represented in fig. 3, the core consists of a polygonal ring made of insulated iron wire of the best quality, so wound as to leave several concentric air spaces in the core. In the converters of the smaller sizes, the core is built up of perforated thin iron plates, fig. 4. In either case, the apparatus is so proportioned that the efficiency of the converter is little less with half than with full load.

Upon each side of this core or iron ring is wound a single layer of heavy copper wire. The four or five single layer coils carried by each half of the core are joined in series and the two groups, borne by the two halves of the core, are joined in multiple, the whole constituting the secondary coil. The terminals of this secondary coil connect with the secondary main line running into houses and supplying current for the lamps. Most of the converters are wound so as to give a secondary difference of potentials of about 100 volts, but may be connected to give 50 volts and twice as many ampères as before. They are made in sizes that supply each from five to 250 16-candle-power lamps or more.

Between the fine iron wire of the core and the heavy copper wire of the superposed secondary coil, insulating pads $\frac{1}{8}$th of an inch thick, are placed at the corners of the core. Between these insulating corner pieces are insulating air spaces. Thus, the copper and the iron are separated from each other at the corners of the core by their respective coverings and the insulating pads, and at all other points by their respective coverings and

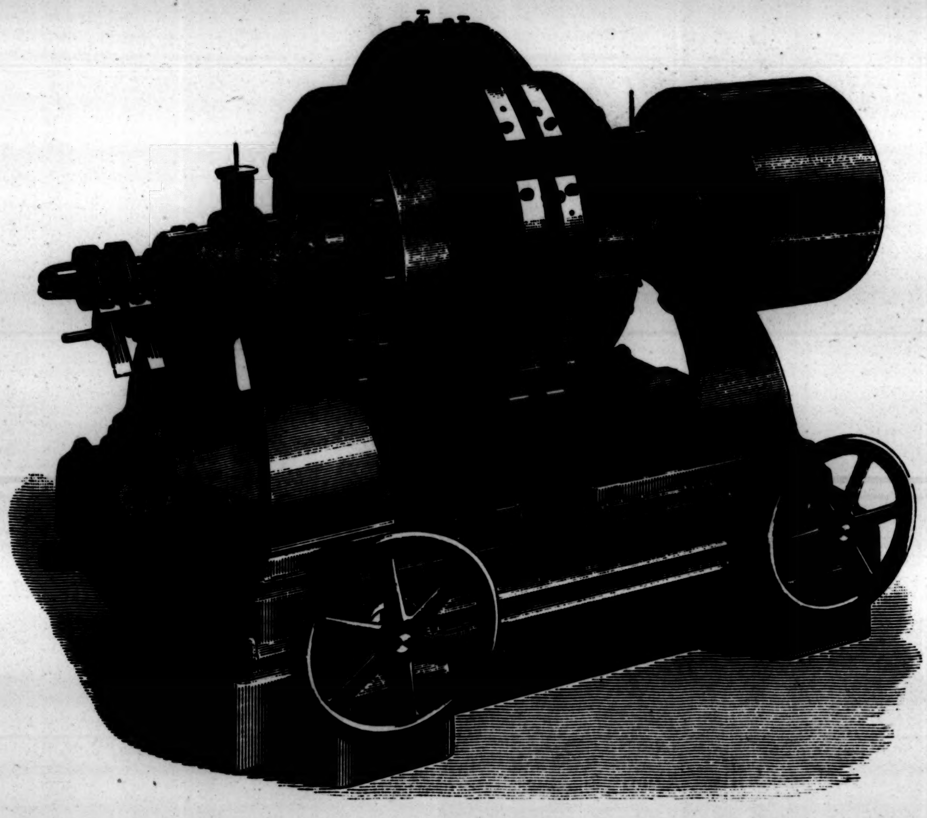

Fig. 1.

open air spaces, the latter affording ample ventilation and facility of examination.

Over each of these single layer parts of the secondary coil are bound a few layers of smaller copper wire to form a corresponding part of the primary coil. These corresponding parts of the secondary and primary coils are separated from each other by insulating pads at the corners and intervening air spaces in the same manner and with the same advantages as previously described, fig. 3.

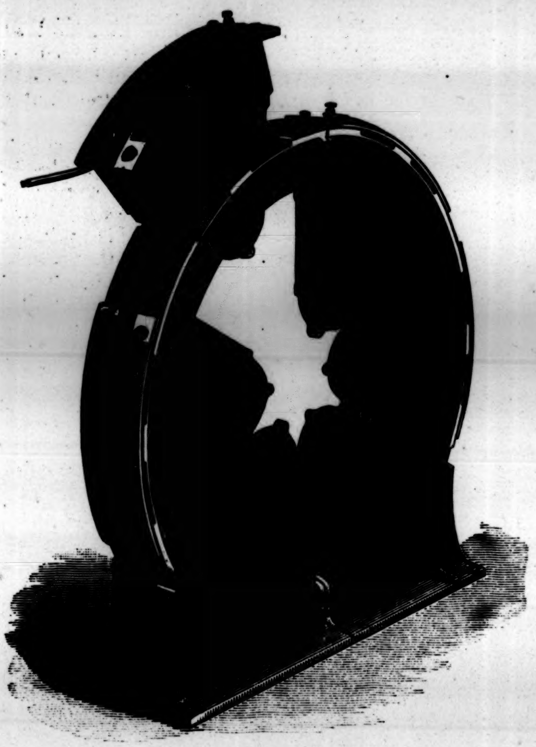

FIG. 2.

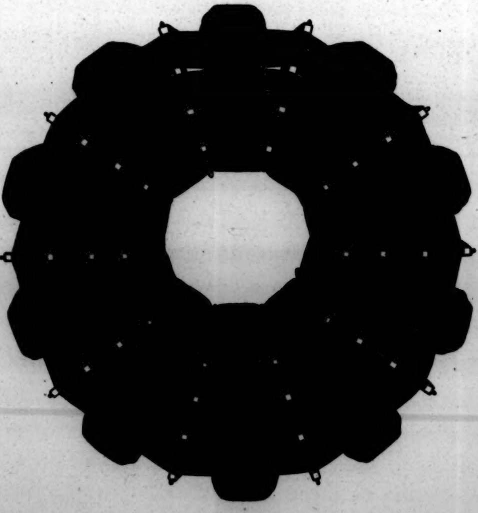

FIG. 3.

The converters are tested at the factory with double load and none has ever given out. Yet, to make safety doubly sure, overloading is made impossible by the use of safety fuses for the primary coils. These are extra long, so mounted on slate or porcelain strips that they can be removed or replaced with ease. The whole converter is placed in a circular cast iron case.

With converters, as with dynamos, the larger sizes are the more economical. With a 100-volt converter fed by a 2,000-volt primary current, it is easier and more profitable to run a short secondary main to supply several consumers than to provide a converter for each consumer. Of course, the latter may be done if, for any reason, it seems desirable. But the Brush Company prefers, when practicable, to use large converters each supplying several consumption circuits.

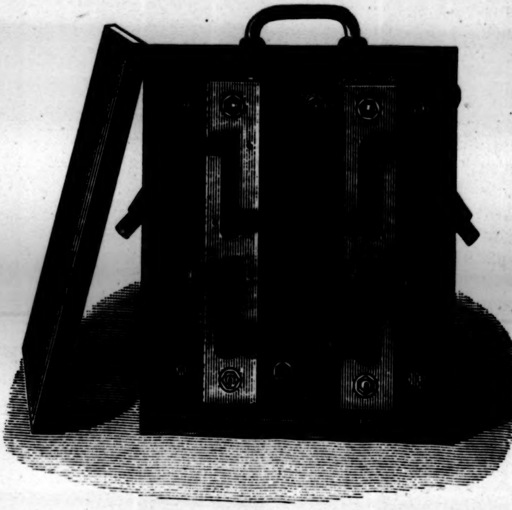

FIG. 4.

ELECTRIC LIGHTING IN LONDON.

BILLS BEFORE THE LORDS' COMMITTEE.

THE Select Committee of the House of Lords—the Earl of Limerick (Chairman), Lord Lauderdale, Lord Lindsay, Lord Ellesmere and another—sat on Tuesday, August 6th, to consider the various provisional orders for the electric lighting of London.

Mr. PEMBER, Q.C. (who with Mr. Moulton, Q.C., and Mr. Loyd, appeared for the London Electric Supply Corporation), after stating that he hoped the Committee would particularly bear in mind that his company had no objection whatever to the introduction of any amount of competition in their district, as he believed the system of the corporation was the best, proceeded to explain that there were two methods of electricity. There was the direct system, viz., that by the direct current; and the alternating system, viz., that by currents which were constantly alternating. The company for which he appeared had always considered one of the main objects to be achieved was to keep the generation of electricity as far as possible outside London, and for that purpose they had perfected, as they hoped, an adaptation of the alternating system, which consisted in generating the electricity, and in the first instance distributing it at a very high pressure from one generating spot. For that purpose they had purchased a large area of land at Deptford, where was generated all their electricity by a large system of engines and other plant, and the current was sent along the railways by means of trunk mains into London, so as to avoid as far as possible interference with the streets, and through the trunk mains the fluid was conducted at a pressure of 10,000 volts. When it reached London it was sent to a number of sub-stations, where it was transformed to a pressure of 2,000 volts by an ingenious, but comparatively small, piece of machinery, and with scarcely any appreciable waste it was then redistributed to public buildings and private houses at a reduced pressure of 50 to 100 volts, to suit the particular requirements of the consumers. It was really analogous to the gas companies making their gas in vast quantities outside London, then sent through their great mains to the different centres of the metropolis, then by smaller distributing mains under the streets, and then by still smaller ones into the houses. The merits of the system of the London Electric Supply Corporation and of the sister system of the Metropolitan Company, as well as what he might term the rival systems of several other companies, had been fully investigated at the important enquiry before Major Marindin, and therefore he (Mr. Pember) scarcely thought their lordships would desire to embark into another investigation. The result of that enquiry was that London had been mapped out into various districts, which were allotted to different companies, the direct and alternating systems being allowed to compete in the same districts. There were now several petitions against his company's Bill, but only two of them opposed the preamble. There was that of the London County Council, which dealt especially with the bridges, and there was one of the Metropolitan Railway Company. Mr. Freeman represented the Council, but he (Mr. Pember) did not know whether the Metropolitan Company was represented.

Mr. Littler, Q.C.: Yes, I appear for the Metropolitan Railway Company.

Mr. Pember remarked that the points raised by the Metropolitan Company were entirely with reference to clauses, and therefore they had no Parliamentary *locus standi* to appear. Then there was the Lambeth Vestry, but having agreed to terms with them their petition was as good as withdrawn. The only two petitions that were left for him to deal with were those of the St. James's and Pall Mall Electric Light Company and of the City of Westminster Electrical Syndicate. The former was as follows:—

"Your petitioners are injuriously affected by the Bill, and object thereto.

"By the preamble of the Bill it is recited that it is expedient that the several provisional orders made by the Board of Trade under the authority of the said Acts as amended by Parliament and as set out in the schedule thereto (including therein a provisional order granted to the London Electric Supply Corporation, Limited, hereinafter referred to as 'the undertakers') should be confirmed. This your petitioners submit is incapable of proof.

"In the said order the undertakers are authorised to supply electricity *inter alia* within the parish of St. James's, Westminster.

"Your petitioners are a limited company to which a licence was on the 10th day of December, 1888, granted by the Board of Trade to supply electricity within the whole of the said parish of St. James's, Westminster.

"Your petitioners have duly performed all the obligations imposed upon them by the said license, have spent large sums of money in the erection of works and buildings and in laying mains and works, and are supplying light to many important buildings, and will shortly be in a position to supply all the requirements of the said parish, and there is no reason whatever why the undertakers should also be authorised to supply electricity within the said parish.

"Your petitioners are advised and believe that the system proposed to be adopted by the undertakers within the said parish should the said provisional order be confirmed, will injuriously affect the works and property of your petitioners and the efficiency of your petitioners' mains without conferring any benefit whatever upon the inhabitants of such parish.

"Your petitioners are informed that the total area in respect of which the undertakers have obtained provisional orders to supply electric light comprises an enormous population, and will require, at a most moderate estimate, in order to carry out the same efficiently, capital vastly in excess of their nominal capital.

"Your petitioners are advised that the undertakers are proposing to adopt a system which is not only uncertain, but also dangerous to life and property, and, furthermore, a system that cannot be efficiently utilised for motive power or for electric deposition or other chemical uses.

"The system proposed to be adopted by your petitioners is certain, absolutely innocuous, and is applicable to motive power and other uses.

"The public thoroughfares and streets within the parish are some of the narrowest and most crowded within the metropolis. Your petitioners have already laid down mains in many of the more important of such streets, and submit that the laying down of a duplicate set of mains would cause great inconvenience to the residents in the said parish, without any corresponding advantages to the public, while the narrowness of such streets would necessitate the laying of the undertakers' mains in close proximity to, if not in immediate contact with, the mains of your petitioners.

"Your petitioners are prepared to show that they are in a position to supply electric light within the whole of the parish of St. James's, Westminster, and to fully carry out the same to the satisfaction of the inhabitants of the said parish, and so as to meet the full requirements thereof, and they submit that no injury will be caused to the residents and public within the said parish should the proposed powers not be granted to the undertakers.

"Your petitioners are advised that the financial resources of the undertakers are inadequate for the due execution of the undertaking.

"The preamble of the Bill is incapable of proof, and cannot be substantiated by evidence."

The petitioners concluded with the prayer that the Bill might not pass in its present form, and that they might be heard by counsel.

Mr. Pember contended that the petitioners were distinctly opposed to competition in the parish of St. James's, Westminster. But so far as he understood the whole theory of electric lighting competition was exactly what Parliament had in the interests of the public, approved in both the Acts of 1882 and 1888. During the whole discussions which led to those two Acts, Parliament had steered clear of the approving of the application of any such monopolies as in the case of the gas and water companies. The petitioners took exception to the amount of capital of the London Corporation. That question had, however, not only been thrashed out before the Board of Trade inquiry, but he did not see what it had to do with the petitioners. And several other of the allegations in the petition really had nothing to do with the petitioners, who, although they might object to the clauses, had no *locus standi* on the preamble. He also objected to the City of Westminster Electrical Syndicate petition, which it would be better for him to read at length. After some preliminary paragraphs it stated:—

"Your petitioners' company was formed by some ratepayers of Westminster, who felt that there was a general demand for electric lighting in their district. Some of their number were well acquainted with the views of the united vestry of the parishes of St. Margaret and St. John, Westminster, and having learnt authoritatively that the vestry would not consent to their or any other scheme, for this session, on various grounds, but chiefly that they considered that no sufficient demand as yet existed for the supply of electric light within their district, that the whole scheme of electric lighting generally was of an experimental character, and that the grant of any licence or order within the above-described districts was premature, as time ought to be given to the vestry to consider whether or not they themselves should take the matter into their own hands, your petitioners were advised that it was desirable that they should carry out practically some portion of their scheme, so as to be able thereafter to approach the vestry with the result of their working in Westminster, after a sufficient period should have elapsed, to afford proof of what could be done; and your petitioners acting on such advice, and relying upon the express provisions of the General Electric Lighting Act of the last Session (section 1), that no provisional order authorising the supply of electricity within the district of any local authority (in this case Westminster) should be granted except with the consent of the local authority (in this case the vestry of the united parishes) unless in the very special case of their consent being dispensed with, intentionally abstained at that time from making any formal application to the vestry, or from appearing before Major Marindin at the time of his holding the Board of Trade public enquiry.

"Your petitioners, who have a station at Chapel Place, Broadway, have since July, 1888, successfully carried on their works on an economic and effective system, laid out with a view to a large further extension when the necessity shall arise.

"The pending provisional orders purport to be made under the provisions of the Electric Lighting Acts, 1882 and 1888, but your petitioners point out that by section 1 of the latter Act, it is expressly provided that no such order should be granted, except with the consent of the local authority, unless the Board of Trade should be of opinion that, having regard to all the circumstances of the case, such consent ought to be dispensed with, in which case they are to make a special report, stating the grounds upon which they have dispensed with such consent, yet, as your petitioners allege, and as the fact is in the present case, the consent of the local authority has not only not been obtained to either of the said orders, but is withheld, and the confirmation of the same was opposed in the House of Commons by the local authority, and the Board of Trade have made no special report stating the grouuds upon which they dispense with such consent, and your petitioners allege that the recited Acts do not authorise the granting of any such orders as those proposed to be confirmed; and that the Board of Trade omitted to lay before Parliament, or before your Right Honourable House, any special report in accordance with the provisions of the said Act, or any report stating grounds upon which they have dispensed with the necessary consent of the local authority, and, therefore, that the proposed orders are absolutely void *ab initio*. And your petitioners allege, that they being so advised, and believing that they could safely rest upon the express provisions of the said Act, did not petition against the said Confirmation Bill in the House of Commons, assuming that the committee of that Honourable House, to whom the Bill was referred for consideration, would refuse to proceed unless and until the consent of the local authority (who were petitioners against the Bill) had been proved, or a special report of the Board of Trade produced, but in lieu of doing so, the committee of the said Honourable House (although they found, as a fact, that the Board of Trade had not made any special report stating the grounds upon which they had dispensed with the consent of the local authority), nevertheless allowed the Bill to proceed.

"In consequence of that decision the vestry have resolved to cease further opposition to the confirmation of the said intended orders, but have not consented thereto, and considering that your petitioners ought to be placed, so far as practicable, on a footing of equality with the promoters of the other electric schemes, passed on the 24th July inst. the following resolution: 'That the vestry consent to the application for a license for a supply of electricity by the City of Westminster Electrical Syndicate, Limited, subject to an agreement for the protection of roads and footways to the satisfaction of the vestry or their surveyor and sureties for its fulfilment, also upon the terms named in the letter read this day, and that the draft license, when received from the Board of Trade, be referred to the Works Committee, with authority to examine and report thereon.'

"Your petitioners humbly submit that, as ratepayers and owners of property in the said district affected by the proposed orders, and as suppliers of electricity therein, they were entitled to rely upon the statutory protection given by the said section of the said Act, and they respectfully submit that the committee of the said House of Commons misunderstood the powers of the Board of Trade to make such orders, as the same were not in a position to be confirmed, and that the committee should not have proceeded with such Bill under the circumstances.

"In approaching your Right Honourable House, your petitioners most humbly, but firmly urge that they were entitled to rest upon the assurances they had received, that the consent of the local authority would not be given to the proposed orders, and that the Board of Trade have not complied with the provisions of the said Act of Parliament in the matter of the said orders, and that the said Act does not authorise the Board of Trade to make any such order as it professedly has made.

"Your petitioners submit that the granting of either of such orders would most prejudicially affect them in carrying out the contracts for supplying electrical energy to the area in which they are working, and over large parts of which they have already, without any official authority, obtained by purchase, grant, license or otherwise such easements and privileges as enable them to supply electrical energy and carry on their business, and would place them in unfair competition with what would then be Parliamentary companies.

"Your petitioners urge that if Parliament should think fit to confirm either or any part of such orders, that special provisions should be inserted therein, saving your petitioners' position, vested interests, and rights, and reserving to your petitioners concurrent rights in the whole district now conceded to them by the vestry, or else reserving out of the district, by the Bill proposed to be allotted to the said other companies, such area as would enable your petitioners to carry on their business without undue interference by either of the companies promoting the pending orders.

"So far as regards the London company, your petitioners allege that the project of supplying electrical energy from a station at Deptford, at the extremely high pressure proposed by that company, is of such doubtful success, and so experimental in character, and probably dangerous in working, that the same should not be sanctioned until further tested, and that in any case no district in Westminster should be reserved to them which can be supplied by your petitioners.

"In the matter of the order called the Westminster order, the company therein described and herein called 'the Westminster company' have not yet, so far as your petitioners have been able to ascertain, produced either to the local authority or at the Board of Trade inquiry, any proof that they have any funds of their own sufficient to enable them efficiently to carry out the undertaking of supplying energy to the district they seek to make their own. Your petitioners allege that the Westminster company have no 'Register of members,' that no 'List of shareholders' has been filed with the Registrar of Joint Stock Companies, and that no statutory meeting has been held, although all such matters are expressly required by the provisions of the Companies Acts, and your petitioners would venture to ask that inqniry should be made, prior to the order for the Westminster company being confirmed, as to whether that company is relying upon its own resources with the intention of carrying out its undertaking itself, or whether (as is currently reported) they have already entered into certain provisional arrangements for carrying out their undertaking either in partnership, or in connection with one of the other companies seeking powers in the present Session of Parliament, or some other company.

"Your petitioners allege that the general feeling in Westminster is, that the interests of the district would be best served by granting orders to companies who should work in special divisions of adequate size, and who should be prevented from amalgamating with any neighbouring company, so that the public might have the opportunity of noting the results of various systems of working, and, further, that it is the general desire that such companies should be locally constituted, and worked and directed by persons, as in the case of your petitioners, having local interests.

"Your petitioners hold a long lease of a valuable site for their new central station, almost adjoining the gardens adjacent to the buildings to the Houses of Parliament, in Millbank Street, of sufficient size for plant and machinery capable of supplying current for upwards of 90,000 lamps, and have already incurred considerable expense in connection therewith, and your petitioners are about to fit up this station with plant and machinery of the latest and most approved type.

"Your petitioners have this year taken all necessary steps, in compliance with the provisions of the Electric Lighting Acts 1882 and 1888, to obtain a provisional order in the next session, and they have, as before stated, quite recently obtained from the said vestry their consent to a grant by the Board of Trade to them of a license under the same Acts effective for the whole of the united parishes.

"Your petitioners also object in various respects to the details of the proposed provisional orders.

"The preamble of the said Bill, so far as it relates to the confirmation of the said orders, is unfounded, and cannot be substantiated by evidence, and the clauses and provisions of the said Bill and orders will prejudicially affect the rights and interests of your petitioners, and no sufficient provisions are contained in the said Bill for their protection."

Mr. PEMBER having criticised several of the clauses of the above petition, argued that the syndicate had no Parliamentary *locus standi*.

Mr. LITTLER, Q.C., stated he appeared also for the syndicate, and contended that they were clearly entitled to appear against the order. He quoted the Act of 1882, and gave several precedents in analogous cases in proof that he was absolutely entitled to be heard against the Bill. Besides that the syndicate were actually carrying on business in the district, and had spent several thousands of pounds of their capital. Were they, he asked, to be put in a worse position than others who had Parliamentary sanction to compete with them? If the Committee decided against the claim of the syndicate to be heard they would be flying in the face, so far as his district was concerned, of an Act of Parliament which distinctly said they had a right to be heard if—as was the case—they would be injured.

Mr. PEMBER having, in answer, urged that the syndicate was not in a position to oppose his Bill, the room was cleared. Upon the parties re-entering.

The CHAIRMAN said: The Committee have decided that the *locus standi* has been established.

Mr. BIDDER, Q.C., (who appeared for the St. James's and Pall Mall Electric Light Company) said: After that I do not think you will oppose me, because I have an actual license?

Mr. PEMBER: No, I do not think so, because this is a stronger case.

Lord CRAWFORD was called in support of the Corporation Bill, and examined by Mr. LOYD, said he was chairman of the corporation, the directors of which were, with one exception, the same as those named in the articles of association. The exception was that of Mr. James Staat Forbes, who had since joined the board as chairman of the finance committee. By its memorandum of association the company was limited in its operations to the London postal area. Its authorised capital was £1,250,000. Of that £800,000 had been already subscribed, and £585,000 paid up.

Mr. LOYD: And about £500,000 has been actually expended on works?—Yes.

The company was formed for the purpose of taking over, as a going concern, the Grosvenor Electric Lighting Company?—The company was worked from 1885 under the name of the Grosvenor Company, and the original directors of that company are the directors of the present company, and have thus had four or five years' experience of electric lighting.

The premises in Bond Street were too restricted, and you had more orders than you could supply from that centre?—Yes.

And that led to some dissatisfaction among the customers?—We were called upon by the customers to do more than we could do satisfactorily.

So that you had to look for more extended premises?—Yes, there was no room in those premises to extend our business.

And it is the result of your experience—looking to the noise, vibration, and other difficulties in carrying on the generation of electricity in populous centres—that it would be better to go further afield with the machinery?—Yes. We considered whether it would not be better to go away from the metropolis, so as to carry on our business without annoying so many persons.

You will have no moving machinery whatever in any crowded part of London?—None whatever.

And no generating station in the crowded parts, so that there will be no carting of coal?—There will be no generation within the ordinary crowded parts.

Your system consists in bringing up your current at a tension of 10,000 volts in your trunk main from Deptford, reducing it by transformation to a tension of 2,000, and then by distributing mains from your distributing stations, taking it through the streets to the consumers' houses or groups of houses?—Yes.

And by that means there is a further reduction of tension from the 2,000 to 50 or 100 volts?—Yes, as the case requires.

The transformer is not a moving machine, but the tension is lowered simply by conductive action?—Certainly.

There is no moving machinery, smoke or noise involved in the transformer?—No.

(*To be continued.*)

THE PACIFIC CABLE: ADMIRALTY SURVEY.*

CANADA has deputed the Hon. J. J. C. Abbott as Commissioner to attend the approaching Intercolonial Conference in Australia, and we may expect soon to hear of further definite proposals for the early completion of Mr. Sandford Fleming's project for a cable from British Columbia to the Antipodes *via* the Sandwich Islands. We all know how important a bearing upon the feasibility of this cable is the condition of that part of the bed of the Pacific Ocean which lies on the track between Canada and Australia. Upon the systematic survey of this track H.M.S. *Egeria* has for some time been engaged, and in the report on Admiralty surveys for the year 1888, which the hydrographer, Capt. W. J. L. Wharton, R.N., F.R.S., has only just presented to both Houses of Parliament (though it is dated 30th April, 1889), we learn how the work has progressed. The *Egeria*, it may be mentioned, is a vessel of 1,010 horse-power (indicated) and of 940 tons, while her complement of officers and men is 122. She is, in fact, the largest and most powerful of Her Majesty's vessels engaged in survey work, the next in horse-power being the *Myrmidon*, which has been engaged upon the survey of the north-west coast of Australia, and which has an indicated horse-power of 720, and a tonnage of 877. In the report before us, the hydrographer states:—

"Good Progress" Made.

For some years it has been evident that the time has come when in the general interests of navigation a systematic examination of the bed of the Pacific Ocean between New Zealand and the Sandwich Islands should be undertaken in order to verify or disprove the many doubtful dangers reported to fix the positions of the islands, and to survey such groups as lie on the track between the great British possessions of Canada and Australasia. The growing desire to see these countries united by a telegraphic cable added to the desirability of this work being begun, renders a firm foundation in the shape of correct positions of islands and a preliminary knowledge of the main character of the bottom between different groups very necessary before any detailed examination of the line of route for such a cable can be made by those who undertake to lay the cable. H.M.S. *Egeria*, Captain Pelham Aldrich, has commenced work on this extensive field during the past year, and, considering the vastness of the area, has made good progress.

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* *Canadian Gazette.*

New Zealand to Tonga: Nothing Less than 204 Fathoms.

On the 20th June the ship sailed on her first sounding cruise, and until the 16th July, when she arrived at Tonga, was occupied in searching for reported reefs in the open sea between New Zealand and Tonga. A few soundings in deep water were obtained on the way north, near Vibilia and Edith Vigias. The Wolverene bank was closely examined during nine days, and though it was found that there is a great rise of the bottom in the position in which that ship in 1878 reported 27 and 40 fathoms, nothing less than 204 could be found, though nine days were spent in traversing the bank in every direction. The bottom showed signs of volcanic *débris*, and it is possible that changes may have taken place since; or it is equally possible that a small rise may exist not found. In any case, it is improbable that any danger at present exists. The bank is a long meridional ridge dropping on either side, but steeper to the eastward.

La Rance Vigia: Nothing Less than 279.

The La Rance Vigia was next examined, and here again, curiously enough, another great submarine mountain was found near the position reported as very shallow, but nothing less than 400 fathoms could be found. Lack of coal obliged the further examination of this bank to be deferred, and the *Egeria* steered for the reef reported by H.M.S. *Pelorus* in 1861. . . . Arriving at Tongatabu, July 16th, the survey of the island was commenced, and carried on at intervals of the sounding cruises during the remainder of the season. The second cruise was commenced on August 21st. During this the La Rance was thoroughly examined, and no depth less than 279 fathoms found. Strong tide rips run over the bank, and probably with floating matter gave rise to the report of shallow water. Deep water lies close all round.

Fiji to New Zealand: Less Unfavourable.

In the vicinity of the other patches reported nothing but very deep water was found. In latitude 24° 37′ S., longitude 175° 08′ W., a sounding of 4,428 fathoms red clay, by far the deepest yet found south of the equator, was successfully obtained. On October 26th another sounding cruise was commenced from Tonga, and though no dangers to navigation were found the bottom proved to be exceedingly uneven and rocky. The Seymour bank could not be found. On November 9th the ship commenced a line of soundings to Fiji, and thence to New Zealand. On this line, though the water is deep, the bottom appears to be less unfavourable for a cable than the line from Tonga to New Zealand. On December 6th Auckland was left to search more closely for the reported reefs south-westward of Kermadec Islands—the Kibilia, Edith, and Somme. Many positive soundings, all in deep water, were obtained near these vigias, but no indication of banks.

Temperatures at different depths were carefully observed at many stations, but the completeness of the series was marred by the loss of a considerable number of thermometers at once through the voracity of a shark, or some other marine animal, that apparently took the uppermost thermometer for a prey, and bit the wire in half. Nevertheless, great additions were made to our knowledge of the temperature of the different strata over large areas.

LEGAL.

The Electric Apparatus Company.—On Monday a petition presented by the company to continue the voluntary winding up under the supervision of the Court came before Mr. Justice North, in the Chancery Division of the High Court of Justice.

Mr. Higgins, Q.C., who appeared for the company and two creditors, said the company was registered on February 23rd, 1884, its object being to carry on the business of wholesale and retail dealers in electrical apparatus. The nominal capital of the company was originally £12,000, but only £3,750 had been called up. The business of the company had recently become unprofitable, and in the month of July of this year, the company not being able, by reason of its liabilities, to continue business, at an extraordinary meeting, and upon due notice, a resolution was passed in the ordinary form that the company be wound up voluntarily, Mr. Friend, the secretary of the company, being appointed liquidator. The company was indebted to its bankers and sundry trade creditors in upwards of £1,500. It was expected that the assets, independently of the goodwill, would be enough to pay all the creditors.

Mr. Cozens-Hardy, Q.C., who appeared for Mr. Montague, said he did not object to a supervision order, but submitted there ought to be a reference to Chambers to appoint an independent liquidator. Mr. Montague had for some time acted as solicitor to the company, and there was a sum of £109 due to him on his bill of costs. The company was also indebted to the Edison and Swan Electric Light Company for £357 odd. Mr. Montague had made an affidavit in which he said no notice had been given to him of the intention of the company to wind up voluntarily, or to appoint Mr. Friend liquidator, until the advertisement of the petition appeared in the daily papers. The affidavit also said that it was undesirable that Mr. Friend should continue liquidator, but that a thoroughly independent person should be appointed to investigate the company's affairs.

After some discussion it was arranged that the voluntary winding up should be continued upon the terms that if Mr. Montague's debt was not paid off within three months he was to have liberty to apply in Chambers for the appointment of a new liquidator, the company undertaking not to enter into any contract for realisation of the goodwill without giving Mr. Montague seven days' notice.

Electrical Automatic Delivery Box.—A petition by this company for the usual winding up order came before Mr. Justice Kay on Saturday.

Mr. Marten, Q.C., appearing for the petitioner: He said the company was registered in January, 1888, when there was an agreement existing for the purchase of certain patents for £30,000—£10,000 in cash and the remainder in fully paid up shares. In July, 1888, an agreement was entered into with Mr. George Myers that he should be manager at a salary of £300 a-year and 5 per cent. on the receipts, but the company did not commence business, because it was found that all the ground on which business could be profitably carried on, viz., the large railway stations, was already occupied by other companies. In November last a petition was presented by shareholders for winding up, but it stood over for a meeting to be called. At that meeting, in December, three shareholders were appointed to confer with the directors, and at an adjourned meeting a report was presented, recommending that the petition should be dismissed, and this was accordingly done on January 12th. The board then resigned, and a new one was appointed, consisting of one of the old directors and two of the shareholders' committee. The new board entered into negotiations with the vendor, and succeeded in reducing his purchase money from £30,000 to £7,150, consisting of £2,750 cash, which had been already paid, and £6,400 in fully paid shares of £1 each. The directors found, however, that there was only £1,000 in hand, and that it was perfectly useless to attempt to carry on business. The idea was that 2,000 machines should be erected, but they had only six, and they could not find any places where they could be profitably utilised. There were about £200 unpaid calls, and about £1,700 uncalled capital; there were also the patents, which were of problematical value. Under these circumstances, the capital being inadequate, and there being no chance of carrying on business at a profit, the directors asked for the usual winding-up order.

Mr. Renshaw, representing shareholders, supported the petition.

Mr. Justice Kay, after some discussion as to the possibility of winding up the company voluntarily, made the order, though with great reluctance, as he feared the whole of the assets would be swallowed up in expenses.

Mr. Marten said he had made inquiries, and he believed in the present case it would be more expensive to have a voluntary winding up.

Electric Transmission of Water Power at Winterthur.—*Industries* says if the project relating to a new canal at Rheinfelden be carried out, an enormous stimulus will be given to electrical engineering, since the power rendered available through the construction of this canal will amount to not less than 11,000 H.P., and will have to be transmitted electrically to Basel, Säckingen, and other places. The project has been worked out, and the undertaking is promoted by three of the best Swiss engineering firms, viz., Escher, Wyss, and Co., of Zurich; the Oerlikon Engineering Works; and Zchokke & Co., of Aarau. The plans are ready, the capital is available, but the concession has not yet been obtained. Since part of the works will be on the frontier, and part of the power will delivered to Säckingen, a concession is required not only from the Swiss, but also from the German Governments, the necessary steps for obtaining which have been taken some time ago. If obtained in time, work will begin in the coming autumn, and the whole undertaking will be completed in 1891. The length of the canal is 1½ miles, its width is 165 feet, and there will be erected a turbine house containing 23 turbines, each of 750 H.P. Each turbine will drive its own generator. The pressure adopted will be sufficiently high to enable the distribution of power to be effected economically within a distance of 15 miles. The power of the turbines being 17,000 H.P., a total of 11,000 H.P. will be available to the consumers.

CITY NOTES, REPORTS, MEETINGS, &c.

The Cuba Submarine Telegraph Company, Limited.

In the report of the directors presented at the thirty-sixth ordinary general meeting of shareholders on Wednesday, the 7th day of August, 1889, it will be seen that the gross receipts (including the balance brought from last account) amount to £24,980 1s. 11d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the expenses in connection with cable repairs) to £8,434 17s. 2d., leaving a sum of £16,545 4s. 9d. to the credit of revenue account.

Of this the sum of £6,000 has been added to the reserve fund, increasing that fund to £90,000.

The dividend on the preference shares will absorb £3,000, and leave £7,545 4s. 9d., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 9 per cent. per annum, free of income tax, the balance, £345 4s. 9d., being carried forward to the current half-year's account.

The Batabano-Cienfuegos cable, mentioned in the last report as then showing signs of breaking down, was repaired by the company's engineer, Mr. Keith, in May, several faults having been cut out, and wasted parts replaced by new cable to the extent of seven knots. Unfortunately, however, this cable ceased to work on 13th instant, and Mr. Keith has again proceeded to its repair; meanwhile the company has arranged for the use of the Government land lines as before. This section, which is a portion of the original 1870 cable, is in some places in a worn-out condition, and its continuing to work without frequent repair can hardly be expected. The directors have therefore decided to have it duplicated, and this will accordingly be done without loss of time.

The other cables continue in good working order.

In consequence of representations made by connecting companies, the question of a reduction of this company's rate for transit messages has for some time occupied the attention of the board, and as the recent establishment of cables by a French company, connecting Hayti, Curacao and Venezuela with the Island of Cuba, will, it is hoped, result in a permanent addition to this company's traffic, the directors have thought the present a favourable opportunity for lowering its rate with the least prejudice to the receipts of the company. The reduction, which came into force on 1st instant, will entail some loss of revenue, but this it is anticipated will in course of time be counteracted by the expansion of the company's business. One or two unimportant modifications of the local rates have also been made.

The director who retires from the board at this time is Mr. Neil Bannatyne, who, being eligible, offers himself for re-election. Messrs. Gane and Jackson, the auditors, who were elected at the extraordinary general meeting in May, also retire, and offer themselves for re-election.

The meeting was held on Wednesday at 58, Old Broad Street, Mr. F. Low in the chair.

The Secretary having read the notice convening the meeting,

The Chairman said: I have pleasure in congratulating you on the very favourable traffic during the past half-year, which must be highly satisfactory to you. The receipts are £888 in excess of the corresponding period of the previous year, and £3,060 in excess of the half-year of 1887. The charges are, I am sorry to say, exceptionally high, caused chiefly by the expenditure of £1,600 for repairing the Batabano-Cienfuegos cable; the amount left, however, is sufficient for the payment of interest on the preference shares, and for a dividend at the rate of 9 per cent. on the ordinary shares, and for placing £6,000 to the reserve fund, thereby increasing it to the good round sum of £90,000, and leaving £345 to the account for the current year. Since our last meeting we have been getting a number of messages through the French Company, who have established a communication between Cuba, Hayti, and Venezuela, and which we hope will go on increasing, thereby making up for the reduction made in our charges. We have had very serious complaints from the West Indian colonists about the high charges, and we thought it incumbent upon us to make a reduction on the charge for the transit messages. You will see in the report that we have come to the resolution of drawing upon the reserve fund for laying the cable between Batabano-Cienfuegos. The original cable was laid in 1870, being now 19 years old; and, as you will learn from the report, it is far from being in a satisfactory state; we must therefore lay one as soon as possible. We are unable at present to give the estimated cost, as we have not been furnished with the lengths and types required by Mr. Keith, our engineer. The breakdown which occurred on the 13th of last month was successfully restored on the morning of the 27th ult. With these remarks I beg that the report and accounts for the half-year ended 31st June last, and now submitted, be adopted.

Mr. Thomas Greenwood seconded.

Mr. Cockeram asked what was the length of the proposed new cable.

The Chairman: Between 170 and 180 miles; it is the only cable we have had in that section. We have had three to Santiago and Cienfuegos; one was abandoned nearly 10 years ago, the other two are in tolerably good working order.

Questions were asked as to the result of the last five weeks, during which time the reduction had been in operation, and what progress had been made in recouoping the loss of income brought about by these necessary reductions, and as to the average reduction of rates.

The Chairman, replying, said: We cannot give you a direct answer, because we have only got the month's working; but I am happy to be able to inform you that the traffic for the month is estimated to produce within £80 of the amount received from the traffic account in July last year, so there is very little falling off. With regard to the average reduction, it was 67 cents., it is now reduced to 50, a very considerable reduction, but not more than the circumstances demanded.

The reports and accounts were then adopted.

Mr. Neil Bannatyne was re-elected a director.

The re-election of Messrs. Gane and Jackson as auditors gave rise to some discussion, and Mr. Bovill proposed an amendment that only one of those gentlemen be appointed. Subsequently the amendment was withdrawn, and the auditors were re-elected.

The Anglo-American Brush Electric Light Corporation.

Notice was sent round to the shareholders last week stating that a confirmatory meeting was to be held at the offices of the company, Belvedere Road, last Wednesday, the shareholders afterwards receiving a further notice in which they were informed that at the meeting a proposition would be submitted to adjourn the meeting until Wednesday, August 14th.

At the meeting held on Wednesday last Lord Thurlow occupied the chair.

In answer to a question as to why they did not hold the meeting at the Cannon Street Hotel, the Chairman said that all formal meetings had previously been held at the offices on account of saving the expense of a room. Referring to the second circular issued, he thought the few shareholders present would quite understand how matters stood; in consequence of the intervening holidays they had been unable to register the new concern, and it was considered inadvisable to wind up the old company before that was done. In the course of further remarks he said they stood now in a position never occupied before by them. The whole industry of electricity was looking up all round, and there was no reason whatever why they should not derive some profit from the business now as other branches and other industries were doing. The best proof of that was in the formation of new companies and the amount of work they had. Unless they had been able to succeed in forming the amalgamation to compete with other people, they would practically have fallen into the background and ceased to occupy a prominent position. With regard to any further information that would be required, he would answer any questions shareholders wished to put. He had no formal statement to make, and thought the shareholders were fully informed of the decision of the board, which was accepted as wise and prudent at the meeting held at the Cannon Street Hotel. There was nothing further to add than to repeat that if they obtained a substantial quantity of letters from shareholders stating their preference for the next meeting to be held at Cannon Street Hotel as being more convenient and to demand any explanation they had the right to demand, there would be no objection on the part of the directors.

The motion for adjournment was then duly seconded and carried unanimously.

United River Plate Telephone Company, Limited.

The third ordinary general meeting was held, in accordance with the report published in our last issue, yesterday at Winchester House, Lord Thurlow in the chair.

In the course of his remarks the Chairman attributed the small dividend payable to the loss occasioned by exchange, which loss amounted to £14,000. Comparing this year's report with the last one issued it was very favourable, as the last covered a period of 16 months, and the rate per cent. for that time was less than the one they now proposed to pay. The general business was entirely satisfactory, the subscribers having increased to the extent of 50 per cent. The Rosario business, which the company have acquired, was then touched upon, and which has been fully consolidated.

Mr. Alfred Le Rossignol, one of the directors lately returned from the River Plate, spoke for a short time as to the advantages of their system in that district.

(A full report of the proceedings will be given next week.)

TRAFFIC RECEIPTS.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of July were £1,677, against £1,518 in the corresponding period of last year.

The Great Northern Telegraph Company, Limited. The receipts in July, 1889, £24,900; January 1st to July 31st, 1889, £151,200; corresponding months, 1888, £156,000; and of 1887, £150,520.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending 2nd August, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,916.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st July are £2,690, as compared with £2,857 in the corresponding period of 1888. The April receipts, estimated at £7,142, realised £7,144.

NOTES.

Leith Town Council and Electric Lighting Companies.—At a meeting of the General Committee of Leith Town Council, held on Thursday last week, there came up for consideration a report on the notices served on the Town Council by several electric lighting companies. The Committee, on the motion of Bailie Archibald, seconded by Bailie Gauland, instructed the Town Clerk to at once intimate to each of the companies that the Corporation had determined not to give their consent to the intended applications for provisional orders, and that should the companies, nevertheless, persevere in their applications to the Board of Trade, the Town Council, either by itself or in conjunction with the Town Council of Edinburgh, would oppose them. From this resolution Mr. Manclark, who moved an amendment which was not seconded, dissented.

Folkestone to be Lighted by Electricity.—A long discussion took place at a special meeting of the Folkestone Town Council on Wednesday morning upon the subject of fixing the corporate seal to the contract of Messrs. Crompton & Co. to light the west part of Folkestone by electricity. A great deal of opposition was displayed, notwithstanding that the contract was formally accepted some months ago, but the chief members who opposed the scheme turned out to be gas directors and shareholders, and the Mayor ruled that they were entirely out of order, and declined to allow them to vote, so the eventual outcome of the discussion was that the seal was ordered to be affixed. It is very much regretted by the inhabitants, however, that the Lees, the most fashionable and important part of the town, is not included in the scheme. The reason of this is that certain gentlemen, "professing to represent the welfare of the town," and connected with the gas company, have—whether by due or undue influence it is hardly worth while to say—drawn up a petition against it. The petition was forwarded to the Lord of the Manor (Earl Radnor), and he has declined to allow the Lees to be lighted. The senseless action of leaving the Lees, above all other places, out of the scheme has made Folkestone quite a laughingstock in the neighbouring towns. From our knowledge of the Lees it is the only thing which is required to complete the place. At the same meeting no less than five companies gave notice of their intention to apply to Parliament for powers to supply the electric light to private consumers. No action was taken in this matter.

The Waterhouse System.—Messrs. Shippey Bros write to us as follows :—"Our attention has been called to your report respecting the Birmingham Exhibition which appeared in your last issue, wherein you state that patent complications have arisen between our firm and the Westinghouse Company, relative to the 'Waterhouse arc lighting system,' for which we act as European agents. Permit us to point out that what you state is not correct, as the facts are as follows :—The Waterhouse arc light patents have recently been purchased, and are now controlled by the Westinghouse Electric Company, who are also about to purchase our European interests with a view to operate the system in England on the same lines as they have so successfully done in America since Mr. Westinghouse has become owner of the system. The simple reason which prevented us showing this new system at Birmingham has not arisen from patent complications, as stated by you, but because certain foreign patents for further improvements have not yet been granted, therefore it would be injudicious to exhibit just at present. However, we may say that the Westinghouse Electric Company is not in the habit of doing things by halves, and judging from the great strides which the Waterhouse system is making in America, we can safely predict that similar results will follow in this country as soon as the Westinghouse Company makes a start for business here, which they are shortly about to do."

The Electric Light for Hawick.—At a meeting of Hawick Town Council on Tuesday night, a communication from the House-to-House Electric Supply Company was read, asking the Council to support them in an application for a provisional order authorising them to introduce the electric light into the town. Councillor Nelson said he intended to move at next meeting that the Council take the matter up with the view of arranging the best terms they could with the company. Councillor Laidlaw expressed the opinion that the Council ought to take the matter up and provide the appliances themselves.

Electric Lighting in Keswick.—The first meeting of the Keswick Electric Light Company, Limited, was held on Thursday last week, Mr. R. D. Marshall, J.P., presiding. Mr. J. Faucus, engineer, reported that the contract for the requisite plant had been placed with an eminent firm, who would have the machinery ready for use by October 1st, and undertake liability during that month. The local works would be taken in hand at once, so that the customers of the company might expect to be provided with the light when October arrived.

The Lighting of Manchester by Electricity.—At the meeting of the Manchester City Council on Wednesday, Mr. Alderman Lamb, chairman of the gas committee, moved a resolution authorising application to be made for a provisional order for the supply of electricity to the citizens. He pointed out that the town of Bradford was completing preparations for the supply of electric light to the inhabitants of that town. Sir J. Harwood seconded the resolution, and discussed some of the difficulties which surrounded the question. He said the question was one which could not be deferred. The order must be taken up by November next, either by the council or somebody else, and that when once the order was taken up they were bound to supply it to everybody within the area over which the order extended who desired it within three years. Mr. Alderman Thompson also supported the resolution, and after further discussion, the resolution was passed unanimously.

Salford and Electric Lighting.—The application of the Manchester House-to-House Electricity Company, Limited, to authorise the supply of electricity by the company for public and private purposes within the area of the borough of Salford, has been considered by the Parliamentary Sub-Committee of the Salford council. The committee have decided to recommend the council to oppose this scheme, and secondly, to apply, under the Electric Lighting Acts, for powers enabling the council to supply electricity for lighting purposes within the borough.

Electric Light in Breslau.—The Municipality of Breslau have decided to undertake the establishment of a central electric light station.

Telephony in Germany.—The development of telephony in Germany during the past seven years is shown in the following table which has been published :—

Year.	Telephone Systems.	Subscribers.	Length of Wire in Kilometres.
1882	 11	 1,884	 3,770
1889	 176	 33,460	 48,829

The Police and the Telephone.—Although Scotland Yard and the police authorities in this country in general do not appear to have much belief in scientific assistance, things are different on the Continent. Steps have been taken in Magdeburg to connect the head police office telephonically with some of the sub-offices.

Army Telegraphy.—The French Government is taking steps for the introduction of a telegraphic department among the cavalry.

Electric Lighting Companies and the County Council.—At the last meeting before the recess of the London County Council, held on Friday, August 2nd, at the offices, Spring Gardens (Lord Rosebery in the chair), Mr. Alderman A. H. Haggis submitted the report of the Highways Committee, of which he is the chairman. That Committee reported that they considered it would be desirable for the Council to authorise them to deal, during the coming vacation, with any matters within the scope of their reference which might require immediate action on the part of the Council. The Council was aware that extensive powers were proposed to be conferred upon it under the Electric Lighting Bills of this session, some of which might have to be exercised before the Council reassembled; and other matters might arise requiring immediate attention. Should this authority be given, the Committee proposed to report to the Council, at the first meeting after the recess, what had been done under such authority. They recommended as follows: "That the Committee be authorised to deal, during the ensuing vacation, with any matter within the scope of their reference which may require immediate action on the part of the Council." Mr. Haggis, in reply to a councillor, stated that among the matters affecting the question of electric lighting which the committee had to consider was whether the companies should be allowed to open the streets and lay down their mains. The Council had power to object to the companies opening up thoroughfares if they (the Council) thought the proposed plan of opening was an unwise one. Of course it was clear that if the Highways Committee were defeated on the question they would not be able to stop any of the companies breaking up the streets and laying the mains in their own way. The recommendation of the Committee was approved by the Council.

Edison's Phonograph.—Colonel Gouraud informs us that Mr. Edison's private secretary, Mr. Tate, has arrived in London for a conference with him on the policy to be adopted with reference to placing the phonograph on the market. He states that the factory at Orange, New Jersey, is now in full working order, employing over 500 men, with a pay roll of over £1,000 a week, and turning out finished machines at the rate of 15,000 per annum (300 per week). All the parts are machine-made, and interchangeable. Three systems of propulsion are applicable to the "Commercial Phonograph" (being the name given to the latest form of machine), viz., battery power, electric light circuit power, and foot-power. Over 2,000 machines have now been distributed in America, and are in daily commercial use in business offices exclusively, on rental at £8 per annum. The next thousand machines will be shipped to Europe, the first consignment having left last Saturday. These will be distributed to a thousand different agencies in Europe. Mr. Edison has now entirely recovered from the recent injury to his eyes.

How the Deptford Explosion was Caused.—The Board of Trade has issued a report, respecting the official inquiry into the circumstances attending an explosion at the works of the London Electric Supply Corporation, Deptford, on April 9th last. It will be remembered that one man was killed and others injured by the explosion, which was the result of a bend or elbow of copper pipe giving way. In his report, Mr. W. H. Woodthorpe says, that on being tested at the works of Messrs. Storey and Sons, Manchester, the pipe did not appear to exhibit any defect. "I am of opinion," he says, "that the presence of water in the range of piping was the immediate cause of the explosion. The workmanship in the copper elbow was, however, very defective, and although the bend was designed to possess a nominal factor of safety of about ten, it is extremely probable that it would soon have failed under steam at the working pressure. . . . There is reason to think that the pipe would have stood had it been originally sound." Mr. Woodthorpe adds:—"It would appear that nothing suspicious was detected in the outward appearance of the finished bend, or the latter would not have been allowed to leave Messrs. Storey's works. Had it, however, been examined with care, I think some of the defects might have been discovered, although these may in some cases remain hidden. There is good reason to believe that more reliable work would be produced if the manner in which a pipe resists internal stress were better understood by coppersmiths generally." Mr. T. W. Traill, the engineer-surveyor-in-chief to the Board of Trade, adds to the report:—"The whole subject of copper pipes requires careful investigation. None of the methods which have been suggested of strengthening copper pipes have been proved to give absolute security."

The Proposed New Atlantic Cable.—The *New York Herald* says that "application has been made to the Dominion Government to guarantee the bonds of the Canadian Cable Company to the extent of £100,000. Sir John Macdonald and Sir Hector Langevin have expressed themselves as favourable to the plan. The eastern land connection of the proposed cable is Westport, Ireland, and the Canadian terminus is Greenly Island, the intervening distance being 1,900 miles." On the other hand, the Marquis of Tweeddale, chairman of the Anglo-American Telegraph Company, stated at the annual meeting on Tuesday that there was little probability of the truth of the report that the Canadian Government were about to subsidise a company in laying down a cable from this country to Canada, and he could attach no credence to it.

The County Council Condescending.—The Highways Committee of the London County Council, at their meeting last Friday, reported as follows:—"Your committee have acceded to a request made by the Superintending Engineer, Post Office Telegraphs Department, for permission to lead a wire from the underground telegraph system in Cranbourne Street into and along the subway in Charing Cross Road, and, by means of the side entrance or by piercing the wall of the subway, to the new section house now in course of erection for the Metropolitan Police near Cambridge Circus. The permission has been granted upon condition that the work shall be carried out, and that any damage that may be done in its execution shall be made good, under the supervision and to the satisfaction of the proper officers of the Council, and at the sole cost of the Post Office Telegraphs Department."

Metropolitan Electric Lighting.—Since our leading columns went to press we notice the following announcement:—"At the sitting of Lord Limerick's Committee to-day (Thursday) Mr. Freeman stated it had been agreed between the promoters of the Westminster Company's order and the County Council to exclude the Westminster, Lambeth, Vauxhall, and Chelsea Bridges from the area of supply."

Railway Companies and the Post Office.—Judgment was given in the Court of Appeal recently setting aside an order of the Queen's Bench Division. The order was originally made that the Postmaster-General, on the strength of an agreement previously entered into with the Great Western Railway Company, was not liable to incur any share of the expenses if it became necessary for the company's business that telegraph poles containing the respective wires of the two litigants should be shifted. The appeal upset this order and made the Postmaster-General liable, and upon going to the House of Lords the appeal decision was upheld, and judgment is therefore substantially for the company.

The Institution of Electrical Engineers.—A circular has been issued to members and associates of this Institution, inviting them to decide whether the method now adopted for electing the council, or the original form of ballot list, is best. We are told that many voting papers have at times been sent in filled up in such a way as to suggest that the voter's exercise of the right of selection, which is now in vogue, has been more nominal than real; but the proportion of these votes to the whole is not given. We trust that all members will hasten to respond to Mr. Webb's circular, for the administration of the Institution of Electrical Engineers should be settled once and for all in a manner which will not leave open a loophole for comment.

The Scarcity of Gutta-Percha.—A party of thirty dyaks, of Saribas, left Sarawak on the 1st June for Sumatra. There they intend to hunt for gutta-percha. If they meet with success some thousands of their tribesmen are ready to follow. This tribe of dyaks has been almost round the Island of Borneo, and has nearly worked out the produce of the jungles as far as they were able to penetrate.

Aristocratic Technical Advisers.—Since penning our comments upon the Duke of Marlborough's article in the *New Review* we observe that our enterprising and energetic contemporary, the *Financial News*, has taken up the same subject in its usual forcible manner. Speaking of investors, it says: "Are they to be led by the Duke of Marlborough and to withhold their faith from the professional electrician, or *vice versa*."

Birmingham Exhibition.—The attractions of this exhibition drew a considerable number of visitors on the Bank Holiday, though what would probably have proved the most popular features of the entertainment, such as the model coal mine and the telpherage switchback, were not in operation. On Wednesday evening, about 7 o'clock, a slight outbreak of fire occurred, which served to prove the efficiency of the electric fire alarm arrangements in the building. The fireman on duty in the exhibition having received a call, indicating the portion of the building in which the fire had occurred, at once proceeded to the spot with a hand-pump, and in about five minutes succeeded in putting out the flames, which in the meantime had completely destroyed the "Egyptian Mystery."

Proposed Electric Tramline for Eastbourne.—The Mayor of Eastbourne, Alderman G. Boulton, has just received a requisition signed by numbers of the leading business men of the town, requesting that a meeting may be called at an early date at the Town Hall to allow of the preliminary consideration of the proposed electric railway along the sea front from the Wish Tower to Beachy Head, by way of Hollywell Rocks. The Mayor has informed our Eastbourne representative that as the requisition is signed by so many well known residents he will, possibly next week, convene the meeting desired, so that the question may be fairly looked at, and its advantages and disadvantages discussed.

Airdrie and Provisional Orders.—The monthly meeting of this council was held on Thursday night, last week, Provost Motherwell presiding. The council unanimously adopted a recommendation by the lighting committee to the effect that the council should apply for a provisional order empowering them to light the burgh with electricity on their own occount, instead of by the House-to-House Electric Lighting Committee.

A. H. Bateman and Company, East Greenwich.—The business of A. H. Bateman and Company, Limited, in liquidation, with the right to trade under the name of A. H. Bateman & Co., has been disposed of by the liquidator to Mr. W. O. Rooper, of Stafford, and Mr. Frank Harris, of Abingdon, who will carry in on for the future.

Theatrical.—The following is a translation from the *Petit Journal* of a few days since:—"A correspondent writes from Perpignan: Last night an accident happened at the 'Alcazar.' During the pantomime one of the electric light leads parted, and plunged the house into complete darkness. Whilst in this condition peculiar tremblings took place, electric discharges were communicated to the audience, who uttered fearful shrieks. Everything was overturned; tables, chairs, and glasses were reduced to atoms. A few of the spectators were struck down by the electricity. Many remained insensible for long afterwards. Several were seriously bruised." This is about the finest thing of the kind we have yet seen.

Priestman's Petroleum Engine.—The Northern Lighthouse Board has adopted Priestman's oil engines for blowing fog signals in preference to steam or gas engines, effecting a great saving in first cost, no chimney being required, as in the case of a steam engine, or gas works, which would be needful if a gas engine were adopted.

Blowing Hot and Cold with the same Breath!—With feelings of admiration we recently pointed out the spirited way in which the *Evening News and Post* had denounced the public performance of a prominent "medical electrician." They attacked him in no unmeasured terms on two occasions, and it might have been supposed that we had at last arrived at an era when the daily press had become convinced of the necessity of showing up injurious quacks. Yet our evening contemporary, after all this, has published long advertisements for the individual in question. It is difficult to say whether most astonishment is to be expressed at the man advertising in an organ where, if his demonstrations were really genuine, he had been ridiculed, or at the paper taking in an advertisement from a person whom it had denounced. It is, of course, possible that the advertisement may have slipped in by inadvertence, but we should like our contemporary to explain itself.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Chas. L. Baker and Company, Limited.—The first return made by this company since its registration in March, 1888, was filed on the 1st inst. It is made up to the 16th July, 1888, the 14th day after the statutory meeting. The nominal capital is £25,000, divided into 3,000 ordinary and 2,000 deferred shares. The shares taken up are 2,000 deferred and 1,857 ordinary, the former being considered as fully paid, and upon the latter the sum of £3 per share has been called. The calls paid amount to £5,496, and unpaid to £75.

NEW COMPANY REGISTERED.

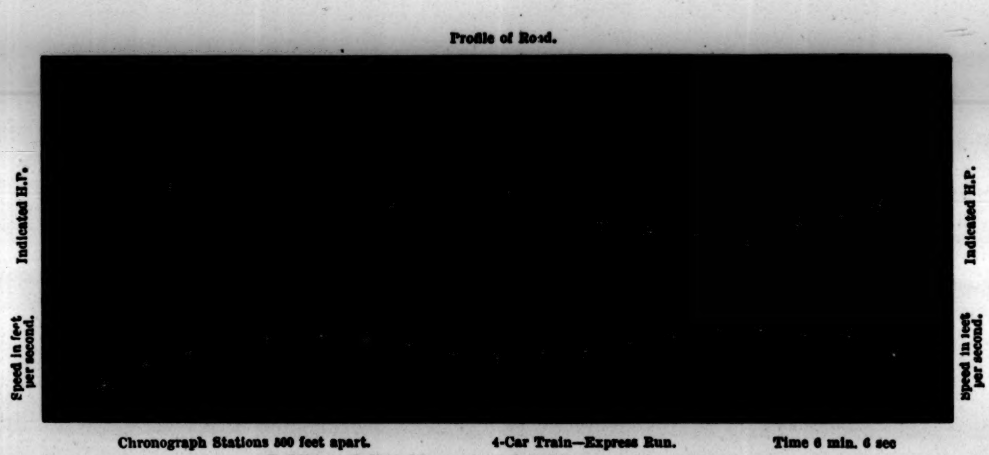
Column Printing Telegraph Syndicate, Limited.—Capital £10,000 in £50 shares. Objects: To acquire certain patents relating to printing telegraph machine upon terms of an agreement of 1st inst. between John Moore and J. E. Wright of one part and J. E. Cockett of the other part. Signatories: John Moore, 5, New Bridge Street, 10 shares; Thos. Lunt, 4, Fenchurch Avenue, 1 share.; J. H. Harris, 128, Coldharbour Lane, S.E., 2 shares; W. H. Ashenden, 14, Philbrick Terrace, S.E., 2 shares; T. J. Bulling, 47, Penshurst Road, S.E., 4 shares; W. P. J. Forbes, Wanstead, 2 shares; J. Genning, 118, Drakefell Road, Nunhead, 2 shares. The first directors will be appointed at the first general meeting. Registered 3rd inst. by Rollit and Sons, 12, Mark Lane. Registered office, 5, New Bridge Street.

SOME RECENT ELECTRICAL WORK ON THE ELEVATED ROADS AND ITS BEARING ON THE RAPID TRANSIT PROBLEM.*

By LEO DAFT.

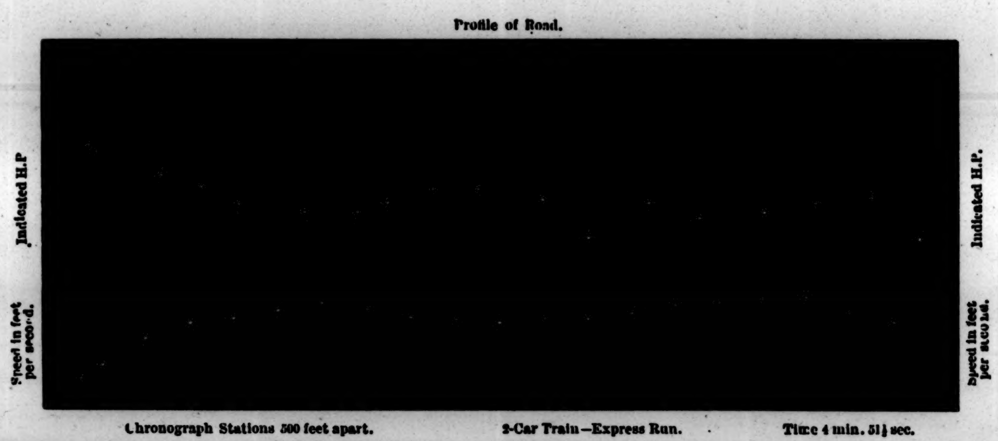
(*Concluded from page* 139.)

Referring to the methods adopted in making the measurement which are plotted in the diagrams, it should be noted that wherever any doubt existed as to the effect of the personal equation in the observations, changes were made in the observers, and the experiments repeated so as to leave scarcely a possibility of any material error; and in order that the always objectionable average statement should not contribute to confuse the result, the diagrams were taken from a number of similar ones, which, after careful examination, were found to most fairly represent the mean effects. They are therefore, within the limits of error in observation, the exact results of actual performance.



Full lines = indicated horse-power, dotted lines = net horse-power.

FIG. 1.—POWER TESTS ON THE NEW YORK ELEVATED ROADS.



Full lines = indicated horse-power, dotted lines = net horse-power.

FIG. 2.—POWER TESTS ON THE NEW YORK ELEVATED ROADS.

In order to measure the speeds with sufficient accuracy for all practical purposes, I divided the track into nineteen sections of 500 feet, each section being provided with a thin copper plate attached to the guard rail at the side of the track and connected with a copper rod or insulated side of the conductive system. This plate was made as short as possible to insure a complete contact without occupying an appreciable interval. A copper brush attached to the motor in such a manner as to travel on the top of the guard rail was connected with one terminal of a chronograph of the well-known type, which we made for this purpose, consisting of a paper-covered cylinder rotated at a uniform speed by clockwork, and a stylus actuated by an electro-magnet so as to penetrate the paper at every closure of the circuit. This instrument was carefully tested and the results verified by experiments before the readings were accepted. The indicator cards were taken at the central station by Mr. Idell and his assistants, after a careful comparison of watches so as to insure synchronism in observing the effects of accelerations and gradients. The dynamometer used was a very fine specimen of the liquid type owned by the Manhattan Railway, and made by Mr. Shaw, of Philadelphia, and after careful calibration by Mr. Shaw and Mr. Idell was found to be accurate within an inappreciable amount. The dynamometric readings I have omitted from these observations, for the reason that they were found to throw so much light upon the ordinarily accepted coefficients of train resistance, under many of the conditions which the text books have not yet considered, and especially the formulæ relating to the subject of acceleration, that time would not permit a thorough digest of the results; hence it was deemed better to leave this part of the subject for later consideration; and I trust you will shortly hear from Mr. Idell on this subject in his usually able and thorough manner.

Referring to the diagram, fig. 1, representing the run of a two-car express train having a total weight of 40 tons, it will be seen that the initial indicator card is exceedingly high as compared with the apparent effort required. The reason for this is that our plan in taking the cards was to make the first one at the instant of closing the circuit, thus giving a card due to the simple dead resistance of the motor which, with a ratio of peripheral velocities necessary for this work and a speed of 30 miles per hour, would necessarily be low and occupy at least a few seconds in developing an economic working resistance, unless a somewhat complicated arrangement was resorted to. But this point will be later referred to.

Following the speed line it will be seen, as might be expected, since we see that the accelerative effort is rapidly diminishing towards the foot of the gradient, that the indicator cards become a minimum at the maximum velocity of the train, but quickly rise beyond Twenty-seventh Street, where the gradient is 98·7 feet per mile. The effect, however, of acquired momentum is here very evident, since neither the indicating cards nor the declining velocity are at all proportional to the resistance imposed by the gradient, and the speed of the train varies but little from this point to Forty-Sixth Street, being only slightly increased on the down grade between Thirty-fourth and Forty-second Streets, due to a change in the combination for the purpose of checking what would otherwise have been too great speed for safety. The dip in the indicator line between Thirty-sixth and Thirty-seventh Streets is occasioned by the cards having been taken at the instant of the change in combination; at Forty-sixth Street the decrease of speed is the result of encountering the gradient, 76·1 feet per mile, and between Forty-eighth and Forty-ninth streets the circuit was opened for the stop at Fiftieth Street, when, as will be seen, the indicator line quickly drops to the friction card only. This run of 1·846 miles was made in 4 minutes and 51½ seconds, as recorded by the chronograph. This is at the mean speed of 22·84 miles per hour, with a maximum of 28·4 miles per hour indicated on the up-grade between Forty-fourth and Forty-sixth Streets. The speed in passing Twenty-third Street, the end of the level stretch, was 28 miles per hour.

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* Read before the American Institute of Electrical Engineers New York, June 25th, 1889.

The mean power exerted at the central station for propulsion during the trip was 103 horse-power, which will compare not unfavourably with steam practice.

Turning to diagram fig. 2, representing a four-car express train, having a total weight of 70 tons, or about the average weight of a four-car loaded Ninth Avenue train, we are confronted with the curious fact that the initial indicator card is lower than that shown with the two-car train; but a careful examination of the two diagrams will show that the card was taken a few seconds after the start, and not, as in the case of the two-car train, at the instant of closing the circuit. The effect, therefore, of the rapid development of working resistance is very clearly shown, and is a most important factor in considering the high initial cards, since they are of only an instant's duration, and hence comparatively unimportant in their effect upon the total power required to run a considerable number of trains at one time. In this run the characteristics of the two-car run are very nearly reproduced, though it is particularly noticeable that the indicator line does not show so large an increase as one might at first thought expect from doubling the number of cars; but this is accounted for by the greater ratio which the friction and load of the moter presents to the two-car train.

The total time of the trip with this train, consisting of four Sixth Avenue cars, each weighing 15 tons, plus the motor, weighing 10 tons, was six minutes and six seconds, with a mean speed of 18·15 miles per hour, and with a maximum speed of 25·24 miles per hour between Forty-second and Forty-third Streets, which is, however, almost equal between Twenty-fourth and Twenty-fifth Streets, when, as above noted, acceleration was still in progress. The mean power exerted at the central station on this run was 129·3, resulting from 91 ordinate readings. The result was almost exactly the same as the running time of the express steam trains of equal weights over the same distance, and may be repeated at any time.

Comparing the two former with diagram, fig. 3, representing a four-car "stop run," several of which were made chiefly for the purpose of demonstrating the ability of so light a motor to stop at the foot of a gradient of 98·7 feet per mile, as at Thirtieth Street, with a train of 70 tons, and ascend the gradient from a position of absolute rest with ease. These "stop runs" with this train were made many times without encountering any difficulty whatever, and at no time during the whole tests has the motor shown indications of over load. That the four-car "stop-runs" were not made in schedule time will be seen by the diagram, but a careful inspection of the same will show the exceedingly prejudicial effect of the absence of an efficient brake system, compelling the opening of the circuit two or three blocks before the station is reached in order to insure a proper stop at the platform. This is graphically shown on the indicator line of the diagram where the circuit is seen to be open at Nineteenth Street for the stop at Twenty-third, thus considerably lowering the speed, and, of course, stopping the rapid acceleration shown on the speed line at the third chronograph station. This disadvantage was so marked that I do not present the four-car "stop-run" as evidence of anything but the ability of the motor heavily loaded to ascend the gradients under the exacting conditions of an exceedingly difficult piece of track.

That there is not a marked difference between the 10-ton motor and the 18-ton locomotive in the initial effort on the level may be seen by comparing a run observed by a Manhattan railroad official, on March 9th last, with a steam motor and three-car train, with 75 passengers, or a total of about 57½ tons. We see that while the steam motor required 1 minute and 39 seconds to make the distance from Fourteenth to Twenty-third Streets, the electric motor in diagram No. 3 accomplished the trip, with a train weighing 14 tons more, in 1 minute and 50 seconds, or only 11 seconds added for the increased 14 tons; surely not a discouraging exhibit, when the fact that while the absence of powerful brakes compelled the opening of the circuit at Nineteenth Street, the throttle of the steam motor was probably open up to Twenty-second Street—although on this point I have no direct evidence, but that is the usual practice.

Before dismissing this diagram, I will again remark that while the mean speed was not equal to the ordinary schedule of the Ninth Avenue Road, it is nearly equal to that of the

Profile of Road.

Indicated H.P.

Speed in feet per second.

Chronograph Stations 5·0 feet apart. 4-Car Train—Stop Run. Time 10 min. 58½ sec.

Full lines = indicated horse-power, dotted lines = net horse power.

FIG. 3.—POWER TESTS ON THE NEW YORK ELEVATED ROADS.

So. Ferry.
Battery Pl.
Rector St.
Courtland St.
Barclay St.
Warren St.
Franklin St.
Desbrosses St.
Houston St.
Christopher St.
14th St.
23rd St.
30th St.
34th St.
42nd St.
50th St.
59th St.

Large circles—Trains under 4 min. headway. Small circles—Trains under 6 min. headway. Dot—Trains under 3 min. headway.

FIG. 4.—DIAGRAM SHOWING THE EFFECT ON H.P. REQUIRED, DUE TO LOCATION OF GRADES WITH TRAINS UNDER VARYING HEADWAYS.

Third Avenue, with 22-ton motors and 80-ton trains. In considering the apparent mean expenditure of power at the central station, it should be borne in mind that the effort exerted by these motors on such rapidly varying gradients, and over such short distances, on the elevated railroads are not by any means represented by the ordinary coefficients of train resistance and effect of gravity, as it has been before pointed out very clearly by others that, while the up grades always exert their full effect, the advantage generally obtained from down grades on long runs by acquired momentum is here nearly always lost by the position of the gradients with reference to the stops. It has been shown by Messrs. Sinclair and Campbell that on the Third Avenue road, with the 30-ton trains and 22-ton motors, 170 horse-power is not infrequently exerted; hence to consider this problem merely by the ordinary coefficients of rolling friction and gravity resistance would, and does, frequently lead to very serious errors in computing the amount of power actually used on short railroads, with frequent stops.

However, it is not my purpose to enter into the niceties of train resistance, since the best authorities differ widely on these points, and theoretical economics form no part of the present subject. But, as I think I am presenting to you for the first time a critical examination of actual competition with steam motors on steam roads in the work of towing entire trains, I trust you will not fail to recognise that electricity is at last measured and weighed against its most formidable opponent in railway practice.

For many years the electric motor struggled hard to prove its ability to compete with even the most costly competitors, namely, manual labour, and even here the introduction of the dynamo machine was necessary to achieve the victory; then quickly followed the long competitive battle with horses, in which it is evident the equine has been signally defeated; and to wrest a victory from the steam locomotive in its own domain is quite another matter; but I think you will agree with me that proof of a large economy in the vital item of fuel under decidedly adverse circumstances, may be so construed without dangerous optimism, and the result of all these tests has seemed to prove that the measurements might be laid bare without in the least shaking the confidence of competent judges in the ability of the electric motor to replace steam for service, at least as severe as that of the elevated railroad systems; and in amplification of the results obtained, we have a diagram, fig. 4, graphically representing the present service of the Ninth Avenue elevated road, where the position and number of trains for all hours of the day are plotted and the actual horse-power required, as shown by the indicator cards.

No. I.

Ten three-car trains, to be run under six-minute headway, between Fifty-ninth Street and South Ferry.

Train No.	Location.	Horse-power required.
10.	Starting at Fifty-ninth Street	200
9.	Up grade to Thirty-fourth Street	150
8.	Running on level	130
7.	„ „	130
6.	Starting at Battery Place	190
5.	„ Rector Street	190
4.	Running on level	130
3.	„ „	130
2.	Down grade to Forty-second Street... ...	...
1.	On switch at Fifty-ninth Street	...
		1,250
	Add 10 per cent. for contingencies	125
	Total horse-power	1,375

Estimated amount of power required to equip, electrically, the Ninth Avenue Division of the Manhattan Elevated Railway.

Ten four-car trains, to be run under six-minute headway, between Fifty-ninth Street and South Ferry.

Train No.	Location.	Horse-power required.
10.	Starting at Fifty-ninth Street	200
9.	Up 52 foot grade to Thirty-fourth Street ...	200
8.	Running on level	150
7.	„ „ „	150
6.	Starting at Battery Place	200
5.	„ „ Rector Street	200
4.	Running on level	150
3.	„ „ „	150
2.	Down grade (52 feet) to Forty-second Street	...
1.	„ „ into switch, Fifty-ninth Street	...
		1,400
	Add 10 per cent. for contingencies	140
	Total horse-power	1,540

Fifteen four-car trains, to be run under four-minute headway, between Fifty-ninth Street and South Ferry. Location of trains when train No. 15 has been run underway two minutes.

This gives larger results than when train No. 15 is starting from Fifty-ninth Street.

Train No.	Location.	Horse-power required.
15.	Down 105-foot grade to Fiftieth Street ...	...
14.	Up 52-foot grade to Thirty-fourth Street ...	200
13.	Running on level	150
12.	Starting at Christopher Street	200
11.	Running on level	150
10.	Starting at Cortlandt Street	200
9.	„ „ South Ferry	200
8.	„ „ Battery Place	200
7.	„ „ Barclay Street	200
6.	Running on level	150
5.	„ „	150
4.	Up grade from Twenty-third Street to Thirtieth Street	200
3.	Down grade to Forty-second Street ...	...
2.	Up 105-foot grade to Fifty-ninth Street ...	250
1.	On switch	...
		2,250
	Add 10 per cent. for contingencies ...	225
	Total horse-power	2,475

Twenty four-car trains, to be run under three-minute headway, between Fifty-ninth Street and South Ferry. Advancing trains one minute from start.

Train No.	Location.	Horse-power required.
20	Down grade to Fiftieth Street	...
19	„ „ „ Forty-second Street	...
18	„ „ „ Thirtieth Street	...
17	Running on level	150
16	„ „	150
15	„ „	150
14	Starting at Franklin Street	200
13	„ „ Barclay Street	200
12	„ „ Battery Place	200
11	Running on level	150
10	Starting at Rector Street	200
9	Running on level	150
8	Starting at Warren Street	200
7	Running on level	150
6	„ „	150
5	„ „	150
4	Starting at Thirtieth Street	220
3	„ „ Forty-second Street	200
2	Up grade to Fifty-ninth Street	250
1	On switch at Fifty-ninth Street	...
		2,870
	Add 10 per cent. for contingencies ...	287
	Total horse-power	3,157

Résumé, and to obtain the average for the day.

Train No.	Cars on train.	Headway.	Time.	Time in service.		H.P.	H.P. hours.
			A.M. to A.M.	Hrs.	Min.		
10	4	6 min.	5 09 „ 6 03	0	54	1,540	800
20	4	4 „	6 03 „ 6 15	0	12	3,157	631
21	4	3 „	6 15 „ 7 00	0	45	3,157	2,367
20	4	4 „	7 00 „ 7 24	0	24	3,157	1,315
21	4	3 „	7 24 „ 7 41	0	17	3,157	1,052
20	4	4 „	7 41 „ 9 03	1	22	3,157	4,209
			P.M.				
10	3	6 „	9 03 „ 4 15	7	12	1,375	9,900
			P.M.				
20	4	4 „	4 15 „ 5 07	0	52	3,157	2,735
22	4	3 „	5 07 „ 5 53	0	46	3,157	2,420
20	4	4 „	5 53 „ 6 13	0	20	3,157	631
10	4	6 „	6 13 „ 9 00	2	47	1,540	2,880
				15	51		29,940

$$\text{Average H.P. per hour } \frac{29{,}940}{16} = 1{,}871 \text{ H.P.}$$

To which must be added the power consumed in engine and dynamo friction and loss in line.

	1,871
Station friction	300
	2,171 H.P.

Evap., 7·5 water for 1 pound coal. Hence coal consumption,

2,171 × 16 × 2·2 = 38 + 3 tons for banking, = 41 tons.
at $2.24, = $92.25 per day.

From this table it will be seen that for five hours out of the 16 of daily service 2,870 H.P. would be required, or, adding 10 per cent. for contingencies, 3,157 H.P., during these times when 20 and 21 four-car trains would be in operation under 3 minutes' headway, being reduced to 1,250 H.P.; or, adding 10 per cent. for contingencies, 1,375 H.P., for the seven hours and 12 minutes intervening between 9.03 a.m. and 4.15 p.m., when 10 trains of three cars are in service under six minutes' headway, while during 54 minutes of the early morning, between 5.09 a.m. and 6.03 a.m., and the late evening service of two hours and 47 minutes, between 6.13 p.m. and 9 p.m., in which case 10 four-car trains are in service, 1,400 H.P. would be required, or, again, adding 10 per cent., 1,540 H.P.

It should be remarked that the power indicated for this service might be very advantageously divided up into four engines of 800 H.P. each, as an examination of the traffic table will show that for only five hours per diem the whole of them would be required, and during the long period of seven hours and twelve minutes, between 9.03 a.m. and 4.15 p.m., two of the engines would be ample for the service.

The results are, however, plotted, and show that the total energy per diem equals 29,940 horse-power hours, or, divided by 16, the number of hours of service, 1,871 H.P. per hour, and adding 300 H.P. for dynamo and engine friction, the total should be 2,171 H.P. per hour, which at 2·2 pounds of coal per horse-power per hour equals 38 tons of fuel consumed per diem, and adding 3 tons for banking the fires equals 41 tons at $2.25 per net ton, or a total of $92.25 per diem for fuel alone.

In this connection I should mention that the coal here referred to is a mixture which may be obtained at the dock in New York for about $1.80 per ton, and which is shown by Barrus, in his work entitled "Boiler Tests," to be capable of evaporating 7½ lbs. of water per lb. in a properly constructed furnace.

There are several makers of compound engines in this country who will guarantee the performance of their engines on 16 lbs. of steam per horse-power per hour. It is thus evident that the amount of coal above referred to is a safe one for modern practice on so large a scale. The present locomotives on the Ninth Avenue require an average of 40 tons of coal per day for motive power and braking, but experience has shown that it is economical in small locomotive practice to use coal of the best quality, hence the cost of this 40 tons of coal is $200 per day, or more than double the cost of that for the electric motive system.

It is of course necessary to add to the electric estimate a number of charges, such as wages of firemen and engineers at the central station, which would probably bring this item up to about $150 per diem, considering other items balanced by their practical equivalent in the present service and the cost of repairs, depreciation, &c., to be about equal, which is not far from the fact.

It is thus evident that without considering the future obvious advantages which must necessarily accrue from the use of a great central station equipped with dynamos, as before stated, and a conductive system ample for all requirements of the road, that with the comparatively wasteful central station arrangement we have here considered, involving the use of small dynamos of a very old type placed at the extreme end of the conductive system, and suffering from many incidental disadvantages, that it is possible to run the Ninth Avenue Elevated Road with electric motors at an actual and considerable saving of fuel to-day; and if this is not the only example of such a practical demonstration, as opposed to direct steam propulsion, it is at least the first I have been able to find on record.

The experience of these extended tests and almost innumerable indicator cards, together with countless observations which have been made during the past eight months, have naturally borne fruit in eliminating many objectionable features which only such an examination could develop, and though, as has been said, it is no part of the object of this paper to treat with other than actually accomplished work, it seems but proper to add that the experience gained in this direction has been embodied in another motor, now nearly complete, capable of not only doing such work as is at present accomplished, but of solving, at least for the near future, the vexed problem of extended traffic for the elevated railroads; and though no actual tests of it have been made, there can be little doubt, judging from the performance of the present machine, that it will be capable of towing at least a six-car train on the Ninth Avenue elevated road with a considerably increased average speed and with a comparatively low initial effort, due to a change in the proportions of parts and manner of winding, to meet the peculiar conditions shown in the diagrams.

In this arrangement the braking of the motor and train has been electrically provided for, also of course, the lighting; but as this machine is not actually finished I will not further refer to it other than to call your attention to a part of the proposed plan, namely, the conductor. A section of which has already been placed on the Ninth Avenue elevated road at the curve below Fourteenth Street.

There are also economies of braking and in the manipulation of the train, to which I cannot at present further allude, which would, however, in all probability, considerably reduce the working expenses. In this motor, the experience which we have had in handling has led to great simplification of the regulating and reversing gear, so that one man may handle the train without the least assistance.

That the plan first suggested by the late Sir William Siemens of braking the trains by converting the motor into a dynamo and so returning a part of the stored up energy of the train to the conductive system would result in considerable economy, there can be do doubt, provided a thoroughly satisfactory method of practical application were applied; but it is an item that does not appear very conspicuously in any of the quantitative examinations which I have yet seen of any electric system, and while I do not wish to be understood as lightly estimating such an obvious economy before accepting it as so important a factor, as its theoretical consideration by some electricians would indicate, I should like to see at least a few carefully digested observations of actual performance with motors of high powers.

In conclusion, I trust that if the foregoing facts are not accepted as conclusive proof that the problem is already solved, that they may at least furnish a sufficient amount of tangible material to assist in the early and complete accomplishment of our most sanguine hopes.

THE ELECTRIC LIGHTING SCHEMES.

Bills before the Commons Select Committee.

Provisional Orders Confirmed.

(*Continued from page* 137.)

As far as that case is concerned, where they actually alter the position of your pipe you are content to accept clause 16?—So far as it goes.

Looking to the extent of your district, the extent of the probable works, and the number of companies you have to deal with, is it impossible that you could deal with those notices and do what was necessary to protect your works within 48 hours?—No, I do not think it is, especially at a time like the present, when electric lighting companies are all especially active. The electric lighting companies will be at work, all at once, all over the place.

And two companies very frequently open up and undertake work in a street at the same time?—Yes. No staff of any company in the world could cope with the whole of these things at a moment's notice.

Then I see the clause goes on to say that the owners (that is you, the Gas Company), "shall be entitled by their officer to superintend the digging or sinking of such trench, and the operators shall conform with such reasonable requirements as may from time to time be made by the owners or such officer for protecting from injury every such sewer, drain, watercourse, defence, pipe, electric line, or work, and for securing access thereto, and they shall also, if required to do so by the owners thereof, repair any damage that may be done thereto." In your judgment is that sufficient to meet the exigencies of the case?—We are advised that it is not sufficient.

You have no wish to be obstructive or to throw any difficulties in the way of carrying out the works contemplated by these provisional orders?—Quite the contrary—our great desire is to work in amity with the electric light companies, and to give them every possible assistance.

I believe your own view is that there is plenty of room for both? There is plenty of room for both of us.

Are there matters in which working in amity with them, you could be of great service to them, and, in fact, save them a great deal of worry and trouble, and probably a great deal of expense in carrying out their works?—If they give us the notice which we ask, we have maps of our mains and pipes everywhere, and we could give them such information as to how they should open the roads, and where they should open the roads so as to prevent their making a great many blunders.

And probably save them thousands of pounds?—And probably save them thousands of pounds every year.

Not only have you maps of all the mains all through the metropolis, but you have an experience of something like three-quarters of a century in dealing with roads?—Yes, ever since the year 1809. —The electric light companies have not any at present.

Are you perfectly willing to give them access to all these maps and plans so as to give them the fullest information and assist them in carrying out their works?—Certainly.

All you ask is that the work shall be so done as not to endanger or interfere with the performance of their statutory duties?—That is the sole object we have in view.

It is the case, is it not, when one of the companies at the beginning of the session was proceeding by Bill, you submitted clauses which, in their essentials, were the same as these, and these clauses were accepted and agreed to be inserted by the agents for the Bill?—Yes, they gave me an undertaking to insert them.

That was the Metropolitan Electric Supply Company?—Yes.

The clauses, though not verbally identical, in their essentials were the same?—Yes.

Cross-examined by Mr. Loyd, Witness said that one of the principal desires of his company was to have proper notice of the works of the electric lighting companies. Whatever provisions were made for not interfering with each other's property should be reciprocal—that was with the exception of priority, the gas companies having been in possession for over 70 years. He desired no favour for his company.

In answer to Mr. Cripps, the Witness said he desired to see reciprocity between the companies in the carrying out of their works.

Mr. Cripps: What danger do you suggest would not be met by section 76 of the order?

Mr. Pope: No danger would be met. It would simply afford a remedy in case of accident.

The Witness: It may meet our case, but I am not a lawyer. As to the question of danger arising from improper insulation, the witness said he would rather the engineer were examined. So far as clause 16 went, he was satisfied as to the provision for the alteration of pipes and wires. In an ordinary way the protection of the order was sufficient, but the directors were advised that under extraordinary circumstances, and in view of the great extent of the mains and the large quantity of plant, the order did not go far enough.

What are the circumstances which you seek to be protected against which this clause does not protect you?—The engineer will tell you.

You went into certain precedents as between you and railway and other companies. Are any of those cases to which you refer analogous to the case of electric light companies which will have, as you say, to go along a large number of streets nearly side by side with your pipes?—Yes, I think so.

In what way, because a railway company is a very different matter?—In the case of railways there are a good many excavations, tunnels, widenings of lines, extensions of great London termini, demolitions of streets, large excavations for the establishment of new stations, and a great variety of work to be done.

Does not the question of electricity put the matter on a different footing from these precedents to which you have referred?—To some extent, of course.

The subject matter here as between you and the Electric Light Company is not the same as what was dealt with in those Railway Acts?—Very nearly, I think.

But you think not quite the same?—Yes.

You mentioned that you have not had to consider this question much since the year 1883?—No.

You recollect that this question of your requiring special protection was considered in a long inquiry in the year 1882?—Yes.

And in the 1882 Act—that is the Public Act—no special clauses were introduced giving you special protection different to what all the other companies were satisfied with?—No.

The gas and electric companies were put by the Act of 1882 in a position of equality in regard to breaking up the streets?—I believe that is so.

Why should gas companies have a different protection than any other companies?—I think the engineer will give you the reasons for that.

The Chairman: Is the general provision for arbitration embodied in the provisional order?

Mr. Pope: Yes.

The Chairman: Where is the question of arbitration laid down in the provisional order?

Mr. Moulton: In clause 16, sec. C of the order.

Mr. Saunders (on behalf of the Kensington and Knightsbridge Company): I believe you have some kind of complaint against the Kensington Company.

The Witness: Hardly a complaint.

It is a personal complaint against the company and not an indictment against the clauses. Perhaps our company may not have been quite right in the way they carried out the clause?—I think it was only a matter of inadvertence on their part. They have not broken the clause.

The Witness, in answer to Mr. Sydney Morse, for the South Kensington order, said he had presented a petition against the Chelsea Electricity Supply Company's order. He knew they had some power already.

Are you aware that we have laid down our mains?—Yes.

With notice to your inspector?—Yes.

And there has been no complaint?—I have not heard of any complaint.

You do not allege that there has been any complaint in your petition?—I am not aware of any.

In the particular case of the Chelsea Electricity Company there are clauses in their provisional order for the protection of the gas company which have been found sufficient?—For all ordinary purposes—small cases—I do not see any objection to them.

The Chelsea Company have laid down in a great number of streets in Chelsea—they have laid down mains for electric lighting—under notice to your inspector?—I have not heard of any conflict at all. I think everything has gone on very satisfactorily between the officers of the two companies.

You have been satisfied in practice with the working of the clauses in the Chelsea Company's provisional order of 1886?—So far as matters have gone.

Then, what can you say against those clauses?—I have only to say, whereas up to the present time the works have been small and the risk has not been great, some of these days you may be dealing with matters very much larger where the risk will be great.

In my case we have been laying down mains in Chelsea, and we are now coming for power to supply an additional area adjoining the parish of Chelsea; as the clauses under which we have been working under the provisional order of 1886 have been found sufficient, why should not they be sufficient for the additional area?—I can only say that it appears to our engineer now that the circumstances will be very different.

Will you show any circumstances of difference?—The engineer will show you.

Mr. Freeman stated that some of the clauses which had been brought up by the Gas Light and Coke Company interfered with the clauses the committee had already passed for the protection of the County Council, and asked the witness whether his attention had been drawn to the existence of those clauses, and whether they did not give the company power to do certain works in the place of the electric lighting companies, and thus interfere with the powers given already to the County Council?

The Witness: I am not aware of it.

If that is so, however, you would be willing that there should be a clause for the protection of the County Council to do works themselves?—Oh, yes.

Mr. Bidder: You do think you know more about your own gas pipes and mains than the County Council?—Yes.

The Chairman: When Major Marindin's inquiry was held during those 18 days, did the Gas Company appear before him?—Not at all.

Sir Henry Roscoe: Are there any other gas companies with mains in the same streets as yours?—No; the companies which were in the district we supply have been amalgamated.

Mr. C. Woodall (examined by Mr. Bidder) said he was a civil engineer and a member of the Institute of Civil and Mechanical Engineers. His attention had been principally occupied in connection with gas works, and he had been engaged in most of the Parliamentary inquiries recently held with reference to gas undertakings. For many years he was the chief engineer of one of the London gas companies, and was now chief engineer of the London Hydraulic Power Company. The streets and thoroughfares of London were very much crowded with mains and pipes for all sorts of purposes—for gas, water, telegraphs, telephones, and hydraulic power. That being so, great care should be exercised in introducing any new system of pipes and mains so as not to injure those already laid down, describing the conditions for laying gas and water pipes the witness said it was important that the level should be maintained in the case of gas mains. That condition was not necessary in the case of water and electric main. The causes which mainly contributed to fractures in pipes were chiefly settlement underneath the pipes and excess of pressure above. Both as to mains and service pipes nothing should be done to prevent the Gas Company getting conveniently at them. With reference to the clauses in the Gas Company's petition, he did not think any of them would work injuriously to the electric lighting undertakings.

Where the service pipes come near the electric mains there would be a probability of some danger?—I am not an electrician and am not familiar with the electric current; but I think provision should be made for a due separation of the two.

Mr. Moulton: You say that you have not given special attention to electricity?—I have not.

But I think you will admit that electricity also has its peculiarities?—Certainly, and many of them.

And probably requires as much skill to deal with as gas?—Most certainly.

You will agree with me that electrical distribution should only be interfered with under the supervision of skilled electrical engineers?—I do, entirely.

Now, further, I think you have heard the counsel on behalf of your clients say that they agree there should be reciprocity in these clauses?—Yes.

And that the obligations and privileges granted to one as against the other should also be granted to the other as against the one; that is so, is it not?—Yes.

Clause 17 deals with the laying down of new works, does it not?—It does.

And it deals with every case of the laying down of new works?—New electrical works.

New electrical works?—Yes.

Therefore that is the one which will come into operation as the companies take possession of their ground, but it also relates to laying down new gasworks where there are already electrical works, does it not?—Yes.

Will you point to anything in that clause which you think insufficient to deal with the question of either party laying down new works?—I have already said that I think this clause is insufficient.

On what ground?—I will take the grounds seriatim. In the first place, it seems to me that the clause is remarkably limited; that is to say, it is limited to the digging and sinking of the trench.

I do not see why those words limiting it in that way should have been introduced.

The Witness further said the time of notice was too short, and that there was no sufficient provision to compel obedience to the reasonable requirements. He thought that it would be fair to have a week's notice for all new works.

Mr. Moulton: If Mr. Woodall thinks a week would not be too onerous on a gas company, I do not think it would be too onerous for an electric lighting company.

Mr. Pope: We cannot dispose of it summarily in that way The committee will take the whole evidence together.

Mr. Moulton (to the witness): I understand you desire that a gas company should have the option, if they like, to execute the work other than the electrical part?—Yes.

And that the electrical company should have the option in a similar case to do the work other than the gas part?—Yes.

That is an alternative offered in clause 16?—Yes; but I think it would be very rarely that such an option would be made available.

Mr. Story-Maskelyne: I suppose, Mr. Moulton, we shall have some evidence as to the size of the mains necessary to convey electricity?

Mr. Moulton: Certainly.

The Witness: The difficulty that seems to arise with the electric light conductors is not so much the size of the conductors as of the chambers in which it is necessary to enclose them. For instance, at Knightsbridge the chamber is something like 2 feet square. That is a serious block in a long roadway.

Have you inquired how many mains could be put into them?—No.

Supposing you had 100,000 lights, it would be about a 4-foot main, would it not?—I really cannot tell you about that.

Mr. G. C. Trewby (chief engineer of the Gas Light and Coke Company), examined by Mr. Bidder, said that during the last few months he had had some experience of the work of a number of electric lighting companies which had opened the ground in the gas company's district. Those companies were the Kensington and Knightsbridge, the Chelsea, the Cadogan, the London Electric Supply Corporation, the Metropolitan Electric Lighting Company, the St. James's and Pall Mall, and the House to House.

How many of those companies gave you notice of what they were going to do?—Only three.

And did they give you notice on every occasion?—No, they did not.

When they did give notice, did they give you a plan of what they were going to do?—No; they simply stated they were going in certain streets.

And work was going on at the same time over a considerable length of streets?—It was.

Your experience of these cases was, that they did not give you sufficient information to enable you to know what was going to be done, or how far it would imperil or interfere with the gas company's mains?—No; we had no detailed information whatever.

Was the system of the Kensington company as to the culverts, a system of which you could approve?—No.

In that case you had to threaten an injunction?—Yes.

The Chairman: We quite recognise the seriousness and necessity of giving full notice, and also of gas and electric companies working together in laying down lines.

Mr. Freeman cross-examined the witness with the view of showing that the power sought by the gas company to do certain portions of the work in connection with the laying down of electric mains would conflict with the power already sanctioned by the committee to be given to the County Council to undertake the work if they thought fit. The claim of the company would thus, he said, clash with the order of the committee as to the County Countil.

Mr. Bidder: I quite agree that there must be no conflict of authority or jurisdiction, and anything required by way of adjustment we shall be happy to agree to.

Mr. Moulton then drew attention to the provision in clause 17 for "not more than 48 hours and not less than 24 hours before commencing to dig or sink a trench," and said he proposed to substitute "seven days." Then by clause 15 the option was given to the County Council to break up the streets and do the work if they thought fit. As the power could not be given to the gas companies to override the Council, he proposed the insertion of the following provision:—"And in case the option given by clause 15 of this order shall not be exercised by any of those therein empowered to exercise the same, then a gas company to whom the provisions of this clause shall apply in respect of the work in question, shall have the right to exercise a similar option on their own behalf on the same terms and conditions with regard to such work." In other words, if the County Council or local authority had not already taken the work of digging and filling up of the trench out of the hands of the electric company, then the gas company should have the option of doing so and of coming second, as it were, to the County Council.

Mr. Bidder: It is very desirable that there should be no clashing of jurisdiction, and the proposed option of our being permitted to do the work ourselves, clears away a good deal of the ground.

Mr. James Swinburne was then called and, in reply to Mr. Bidder, said he was a consulting electrical engineer. He had considerable experience in regard to electrical works and had also been connected with gas works. There were many ways of laying mains for electricity, and it was difficult to say which particular method would be adopted in the future by the companies seeking powers. Some method not now known might come into use. Some of the systems of service pipes and mains required much more care to be taken by the companies to protect them than others. The method of laying under culverts was objectionable, and especially that form in which the culvert was not air or gas tight. There was a liability of sparks being caused in the case of uncovered mains which might touch.

Which plan do you prefer—cast iron pipes or brick culverts?—It depends whether you look at it from an electrical or a gas point of view. From a gas point of view I prefer wrought iron pipes.

In your judgment, is it important to provide, as we do in clause D, for encasing the electric line or wire in an insulating covering?—Yes, it should be thoroughly encased, and the insulation itself should be protected. If anything, that clause is too mild.

Any such arrangement as appears to have been adopted in the Kensington case, of building mains in such a culvert is objectionable, and a gas company ought to have power to prevent it?—Certainly.

Mr. Moulton: I am perfectly willing to say that the gas pipes are not to be used as conductors to complete the electric circuit.

Mr. Bidder: You accept this clause C in substance—you accept the principle.

Mr. Moulton: We are perfectly prepared to agree to a clause being inserted saying that we are not to use the gas pipes in order to complete the electric circuit.

Mr. Bidder: I understand you do accept the principle. Perhaps you adopt also the principle of clause D.

Mr. Moulton: No.

Mr. Story-Maskelyne: I should like to know whether this clause would prevent the gas pipes from being used in any sense for the return circuit of the current supplied. Supposing you had an earth current and it was taken up by the gas pipes, are you ready to introduce some means to prevent it being so taken up.

Mr. Moulton: I think that is met by subsection 2 of clause 9:—"The undertakers shall not permit any part of any circuit to be connected with earth, except so far as may be necessary for carrying out the provisions of any such regulations or conditions as aforesaid, unless such connection is for the time being approved of by the Board of Trade, with the concurrence of the Postmaster-General, and is made in accordance with the conditions, if any, of such approval."

Mr. Story-Maskelyne: Yes, I see that answers my question.

The Chairman: Now Mr. Moulton what do you agree to?

Mr. Moulton: I agree to this—that without the consent of the gas company no portion of their mains may be used as a part of the electric circuit, so that the electricity passes along it. Then, sir, I quite agree that we should not use their works to support the electric works, and to build, as it were, our works on the gas company's works. With regard to the nearness the two companies' pipes approach, that must be decided entirely by circumstances. It may be that we may have to cut into a narrow neck, but that is provided by a clause which specially deals with the question of the works which are near to gas companies works. If it is near then the gas company can, if they like to do the work themselves, if they do it in such a way as to gives reasonable protection.

The Chairman: Do you agree to clause D as to insulation?

Mr. Moulton; No. The question of what is the best insulation for mains is a question which has not yet been worked out, although there are many good systems. There is no insulation so perfect as air insulation, but if this clause were passed in the form in which it now stands it might be held to prevent underground air insulation—that is, the conductor being separated by a space all round from any surrounding body—that has been exceedingly successful, and it is in many ways free from the objections of other systems of insulation. That is a matter which is directly in the hands of the Board of Trade; and if a clause is put in to make definite and fixed regulations with regard to insulation at these points, it takes it out of the hands of the Board of Trade, and that body, which has the duty of providing for the safety of the public, would be hampered by the clause.

Mr. Story-Maskelyne: Would the words "thoroughly insulated" be sufficient?

Mr. Bidder: I am quite willing to adopt the words "to be thoroughly insulated to the satisfaction of the engineer of the gas company."

Mr. Story-Maskelyne: To whose satisfaction?

Mr. Moulton: If there is any doubt as to that it will be settled by the Board of Trade.

Mr. Bidder: Surely the same system should be adopted as in other clauses. *Prima facie* it is to the satisfaction of our engineer. But if your engineer and ours do not agree it shall go to arbitration.

Mr. Story-Maskelyne: Your engineer, Mr. Bidder, is not necessarily an electrician, as we see. (Laughter.)

Mr. Bidder: We will say, "in a manner entirely satisfactory to the arbitrator appointed by the Board of Trade."

Mr. Moulton: So long as it is decided by an arbitrator or the Board of Trade I shall have no objection. But these matters which bear on the question of safety should be in only one hand.

Mr. Story-Maskelyne: In a manner approved by the Board of Trade.

Mr. Bidder: Yes. Now, have you, Mr. Moulton, any objection to clause B? Do you assent to the principle of that?

Mr. Moulton: I adhere to the order—to clause 76, which provides that undertakers are to be responsible for all damages.

Mr. Bidder: Do you agree to the principle of clause F—that we are to be protected from any loss from explosion in consequence of the failure of your works?

Mr. Story-Maskelyne: But is not that included in the order?

The Chairman: The committee are clearly of opinion that everything of that nature, which should be covered by an arrangement of that sort, is covered by clause 76—that is, everything with regard to damage.

After some further discussion upon disputed points in the clauses it was agreed that they should be arranged and submitted to the committee the following morning.

The committee then adjourned.

(To be continued.)

NEW PATENTS—1889.

11636. "Improvements in instruments for detecting and measuring electric currents." P. Jolin. Dated July 22.

11661. "Improvements in thermo-electric and furnace batteries." C. Huelser. (Communicated by H. Mestern, Germany.) Dated July 22.

11676. "Combined station and want printing telegraphs." H. J. Allison. (Communicated by Major D. Porter, United States.) Dated July 23. (*Complete.*)

11705. "Appliances for economising and utilising surplus electricity for lighting, power, and other purposes." F. W. Engelbach and E. B. Bright. Dated July 23.

11732. "Improvements in and relating to electric telegraphs." F. Anderson. Dated July 23. (*Complete.*)

11780. "Improvements in electric generators." C. E. Buell. Dated July 24. (*Complete.*)

11846. "Method of maintaining the constancy of electrical potential difference in the several branches of distributing network, supplied with either continuous or alternating currents." Siemens Brothers and Co., Limited. (Communicated by the firm of Siemens and Halske, Germany.) Dated July 25.

11847. "Improvements in the distribution of electrical energy." Siemens Brothers and Co., Limited. (Communicated by the firm of Siemens and Halske, Germany.) Dated July 25.

11927. "Machine for covering electrical conductors." S. Pitt. Communicated by J. B. Atherton, United States.) Dated July 26. (*Complete.*)

11941. "Improvements in switch boards for telephone exchange." Mix and Genest Company, Limited, and W. Oesterreich. Dated July 27.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888.

8170a. "Electric shunting device." H. J. Allison. (Communicated from abroad by "The Baxter Electric Manufacturing and Motor Company," Incorporated, of America.) Dated June 5. 8d. The object of this invention is to furnish an improved shunt box for connecting successively a series of contacts, and in some instances for connecting two series of contacts electrically through the medium of a single block, and the invention is particularly adapted for varying the course of the current in the magnet coils of an electric motor, as set forth in the patent, No. 8,170, dated June 5th, 1888, in which the same shunt box is shown mounted upon a bridge between the pole pieces, and suitably connected with portions of the field magnet coils. 5 claims.

9171. "Improvements in electric lighting as applied to railway trains." W. E. Langdon. Dated June 23. 11d. Consists in the employment of certain conducting wires arranged in such a manner that in combination with a specially devised electrical coupling, by which the conducting wires may be connected between vehicle and vehicle, and an electrical switch, placed in the guards van or other part of the train, the light derived from the source of electricity, whether primary or secondary battery, arranged on or within the vehicle, may be turned on or off as desired; and further, by the arrangement of a certain spring connection in the said coupling, that when the coupling is disconnected, the electric light circuit shall be so completed as to bring into operation the lights provided for that purpose; and further, in combination therewith, in the employment of a switch placed upon each vehicle by means of which the lighting circuit thereof may be broken or completed as may be desired; and such also that where more than one set of batteries is employed on such vehicle, the said switch, fixed upon such vehicle, may be used for switching in or out of circuit either set of batteries. 8 claims.

9747. "Improvements in electric bells." L. W. Winnall. Dated July 4. 8d. The inventor arranges the hammer on pivots so that it can swing from side to side of the bell. The make and break contact is provided with a spring insulated from the frame, and an insulated pallet so arranged that when the armature is brought up and the hammer strikes one side of the bell the pallet is forced in between the spring and the frame, and thereby breaks contact, allowing the hammer to fall by its own weight and make a second stroke, whereupon the armature withdraws the pallet, and contact being again made, the opposite stroke is effected, and so on. 4 claims.

10194. "Improvements in electrical switches." A. C. Cockburn. Dated July 13. 8d. This invention relates to improvements in switches for use in electric circuits, and consists in a device by which both a quick make and break of circuit is obtained, together with a perfect locking of the contact bar both in the on and off position. 3 claims.

10299. "Improvements in electric logs." N. W. Wallace. (A communication from abroad by P. Scott, of Malta.) Dated July 16. 8d. Relates to improvements in electric logs for which letters patent were granted to P. and A. T. H. Scott, dated the 20th day of February, 1884, and number 3,666; and it has for its object to provide a mechanical, in lieu of a mercurial, timer and contact maker as described in the specification of the aforesaid patent, and in the case of a log provided with means of indicating the total distance run, to provide means of indicating when and for how long a period the log has been rendered inoperative by the fouling of the rotator so that the total distance run may still be ascertained approximately by calculation. 3 claims.

10363. "Improvements in and relating to multiple telegraphy." E. J. P. Mercadier. Dated July 17. 1s. 5d. This invention is based:—1. On the co-existence of the small electric undulations simultaneously occurring in an aerial, underground, or submarine conductor, and their crossing each other without confusion, a continuous current or a permanent electrostatic charge having been previously established in the said conductor. 2. On the employment of radiophonic (photic or thermic) transmitters and microphonic transmitters of novel nature and arrangement. 3. On the employment of novel receivers which separate the electric vibrations of different rhythm. Its object is to transmit simultaneously through the same line in the one or the other direction several signals in accordance with a conventional alphabet. It comprises two modes of transmission, the one teleradiophonic, the other telemicrophonic, and one mode of reception. 18 claims.

10627. "Improved connection for the carbon or agglomerate plates of galvanic batteries." L. J. Dopping-Hepenstal. Dated July 23. 4d. An improved connection for carbon or agglomerate plates or blocks of galvanic batteries formed by a piece of platinum wire or bar of suitable length and size, of which one end is kept by wedge action in close contact with a hole or slit of suitable size through the plate or block. 1 claim.

10730. "Improvements in electric firing gear for guns." A. Noble. Dated July 24. 8d. In such firing gear it is usual to provide an insulated needle in the breech block which, being pressed forward by a spring, establishes electrical contact with the primer in the base of the cartridge. The inventor so arranges that this insulated needle is controlled by the lever which locks the breech block in its place. When the breech block is in place and locked the needle is able to advance; but when the breech block is unlocked the needle is drawn back out of contact with the primer. By the same movement also the needle itself is disconnected from the firing key. 4 claims.

10929. "Improvements in magneto-electric generators and appliances for use in connection therewith." E. Cox-Walker and A. A. Campbell-Swinton. Dated July 28. 8d. The inventors employ an armature of the ordinary shuttle form or any suitable description wound with conducting wire and arranged between the two pole pieces of a permanent steel or other magnet of the usual horseshoe or similar form so that it can be rotated or reciprocated. 1 claim.

10941. "Improvements in the arrangements for the lighting of railway trains by electricity." I. A. Timmis. Dated July 28. 8d. Claims:—1. An arrangement of pulleys and friction wheels for driving a motor wheel in the same direction, whichever way the vehicle may be travelling, in substantially as and for the purposes described. 2. Electro-magnets for putting one or other of the friction wheels into operation, substantially as and for the purposes described. 3. A spring or springs and rollers for keeping the axle pulley belt tight, substantially as and for the purposes described. 4. The general arrangement, substantially as and for the purposes described.

10956. "An electrical lighting apparatus for medical and surgical purposes." C. Smith. (Communicated from abroad by R. B. Nachfolger, Frankfort on the Maine.) Dated July 28. 8d. The invention is constructed in the form of a pair of spectacles, between the eye pieces of which an incandescent lamp is fitted. 1 claim.

11503. "Improvements in electric generators." L. S. M. Pyke and H. T. Barnett. Dated August 9. 8d. The inventors produce electric currents by revolving a magnetic inductor or inductors in proximity to a magnet provided at one pole or at both poles with two or more polar projections, serving as cores for the conductor or conductors in which the current is to be induced, the object of the inductor or inductors being to complete the magnetic circuit alternately through each set of polar projections. 3 claims.

11569. "Improvements in secondary and other electric batteries." H. Pieper. Dated August 10. 6d. Has for its object increasing the capacity and effective action of the electrolytic system, the initial resistance opposed to the chemical decomposition by which work is to be done being artificially increased. This artificial resistance is produced by the application of a pressure which is considerably in excess of the atmospheric pressure, and which is maintained in the battery, being produced either before or during the electrolysis. 7 claims.

13994. "Improvements in and relating to cut-out or safety devices for electric circuits." J. Kendall and O. Cooper. Dated September 28. 8d. Relates to electrical cut-out or safety devices of the kind or class wherein a conductor or connecting piece, composed of easily fusible metal or alloy, forms a part of the electric circuit, so that any abnormal increase in the intensity of the current will cause the fusion of the said conductor or connecting piece, and overheating of the wires in other parts of the circuit will be prevented. The invention comprises a method of providing for the automatic indication, by the sounding of a bell or otherwise, of the fusion of the said conductor or connecting piece, so that it can be at once replaced by a new one, and the inconvenience arising from the temporary cessation of the current will be minimised. 2 claims.

1889.

485. "Improvements in electric generators." H. E. Newton. (Communicated from abroad by D. Piédrahita, of Paris). Dated January 10. 6d. Claim:—An electric generator consisting of two electrodes, the one of carbon, the other of zinc, inserted in the earth, the connection of which will produce an electrical current which may be used for telegraphic or other purposes.

2071. "Improvements in means for automatically cutting out and restoring to circuit instruments or apparatus in telephone, telegraph, fire-alarm, electric light or similar electric systems."

A. B. Ferdinand. Dated February 5. 8d. Relates to electric systems whereby any instrument device or station on a line may be cut out when desired for a given length of time and automatically restored, with the resistance of said instrument, device station practically eliminated during the period of cutting out. 4 claims.

5176. "Improvements in or connected with electrical installations." E. A. Sperry. Dated March 26. 8d. Relates to devices for grounding closed circuits, and has for its object to provide means whereby closed circuits may be grounded when broken so as to continue the service over the same. 9 claims.

REVIEW.

Modern Views of Electricity. By Oliver J. Lodge, D.Sc., F.R.S. London: Macmillan & Co., and New York.

This book will be found full of interest to students not only of electricity, but in the wider field of physical science. The impetus given to electrical theory by the writings of Clerk Maxwell, Sir William Thomson, and other great masters, has been lost to a great extent on those who have not had the good fortune to possess a knowledge of the higher mathematics.

"The object of this work," as stated in the advertisement, "is to explain without technicalities, and to illustrate as far as possible by mechanical models and analogies, the position of thinkers on electrical subjects at the present time."

Dr. Lodge divides the subject into four parts: 1. Electricity under strain or electrostatics; 2. Electricity in locomotion or current electricity; 3. Electricity in whirling motion or magnetism; 4. Electricity in vibration or radiation, commonly called light.

The fact that light is now regarded as a form of electricity shows how great a revolution has been effected in the views of modern physicists.

We must confess, however, that with all the additional light which Dr. Lodge has thrown on the subject, we still seem as far as ever from understanding what electricity really is; the author himself, in fact, while adopting the *incompressible fluid* theory, is still in doubt whether the one-fluid or the two-fluid theory is the correct one.

The first part of the book, as we have stated, deals with the subject of Electrostatics or electricity under strain. This is sub-divided into chapters dealing with fundamental notions, the dielectric, and electrostatic induction. It is assumed that the electric medium fills all space. We live and move in it as we do in the atmosphere, or as fish do in the sea. Electricity itself is an incompressible fluid, but when combined or entangled with grosser matter an elastic medium is produced. It is through this elastic medium, which represents the dielectric, that the phenomena of electrostatics manifest themselves. Dr. Lodge compares this medium to a jelly in which liquid is entangled, but this, we think, gives a somewhat indefinite idea of the structure of the dielectric. In the chapter on Charge and Induction, however, mechanical models are described which illustrate more minutely the action of the dielectric. The elastic dielectric is represented by a number of parallel elastic cords stretched between two fixed parallel beams. Electricity flowing in a closed circuit is represented by an inextensible endless cord attached to the centres of the elastic cords, so that when it is pulled the elastic cords are stretched transversely till the pull is balanced. This operation is analogous to the charging of a Leyden jar.

The theory of the Leyden jar is also illustrated by a hydraulic model. The inner coating of the jar is represented by an India-rubber bag, which is stretched when the charge (of water) is forced into it. Water, at the same time, by the expansion of the bag, is forced out of a glass globe surrounding it. The conductors are represented by pipes, in which the flow of water can be started or stopped by means of stopcocks. Such a model as this is very instructive, but we think would be improved by embodying in it in some way the principle of the elastic cord model. From such a model as this it is, for instance, difficult to see why the capacity of a Leyden jar is greater when the glass is thinner.

One-fluid and two-fluid theories of electricity, as Dr. Lodge points out, are as old as Franklin and Symmer, "*but*," he adds, "*it is their foundation upon ideas of action at a distance that condemns them.*" Well, let us consider whether Dr. Lodge has been successful in getting rid of the idea of action at a distance. There is evidently in Nature nothing corresponding to the fixed beams to which the ends of elastic cords are attached in the cord model. To get over this difficulty, Dr. Lodge assumes that the fixed beams are replaced by rows of negative elements which are displaced in the opposite way to the positive elements, that is to say, a charged conductor must exercise both a pushing and pulling effect on the elements of the surrounding dielectric. It is easy to understand how a pushing effect may be transmitted by the contact of the particles of the intervening medium; but without the idea of action at a distance, we are unable to understand how a pulling effect can be transmitted by an intervening medium.

It is to be regretted that in dealing with the subject of Electrostatics Dr. Lodge has not furnished some mechanical analogy to illustrate the nature of such notable phenomena as the attraction and repulsion of electrified bodies.

The second part discusses the nature of the electric Current. There is quite a startling difference between the modern views and the old views on this subject. The modern view is that the energy conveyed by an electric current is not transmitted through the conducting wire, but through the dielectric medium surrounding the wire. The function of the wire is to guide the wave of electric energy, while it at the same time dissipates a certain fraction of it by converting it into heat. "The energy of a dynamo does not travel to a distant motor through the wires, but through the air. The energy of an Atlantic cable battery does not travel to America through the wire strands, but through the insulating sheath." The higher the conductivity of the conductor the less will be the proportion of the electric energy which will pass from the dielectric into the conductor and be dissipated as heat; in fact, we arrive at the paradox that with a perfect conductor between two bodies at different potentials no electric current will pass through the conductor.

Hitherto it has been considered that the electromagnetic field known to exist round a conductor carrying an electric current was produced by the action of the current in the wire upon the surrounding medium; if the modern view is correct, whatever corresponds to the electric current in a conductor is produced by the action of the medium upon every element of current along the whole length of the conductor.

This theory furnishes one explanation of the fact that experiments have failed to show that the electric current possesses inertia.

The fact of the impelling force being applied to the electric current, also explains why alternating currents flow preferably on the surface of conductors. It is only with steady currents acting for some length of time that the disturbance has time to penetrate to the centre of the conductor.

The author's views on electrolytic conduction contain some novel explanations of these well-known phenomena. Electro-positive chemical elements, such as hydrogen, are supposed to have a constant charge of positive electricity, and electro-negative elements a constant negative charge. The charge is not the same for all elements, but is proportional to the atomicity or number of bonds which the element possesses. The electrical attraction between the positive and negative elements is considered "undoubtedly to be the force with which chemists have to do, and which they have long called chemical affinity." Electrolysis consists of processions of these positive and negative elements in opposite directions.

The old and vexed question as to the origin of the electromotive force in the voltaic cell is discussed. The effective cause is considered to be the greater affinity of oxygen for zinc than for copper; any true contact force between the metals acts as a slight and insignificant disturber of the simple volta effect.

The second part is completed with certain speculations as to the origin of pyro and frictional electricity. The third part of the book deals with the subject of Magnetism. After describing some of the phenomena of magnetism, and explaining the electric whirl theory, which is as old as Ampère, Dr. Lodge proceeds to devise some mechanical models of a magnetic field, to give us an idea of the nature of the mechanism by which magnetism is produced. Taking a plane section through a conductor carrying an electric current, the current itself is represented by a toothed rack, and the field on both sides of the rack is filled with a number of toothed wheels gearing into one another, and into the rack. Any movement of the rack will thus impart motion to the wheels, and *vice versâ*. But a difficulty here arises: one half of the toothed wheels will rotate in one direction, and the other half in the other direction; and as the effect of the electro-magnetic field, for example, in its action upon a magnetic needle is not found to reverse, this model cannot be said to give a correct representation of its structure.

These alternately right and left-handed rotations are found, however, to be very useful in explaining another circumstance in connection with magnetism. If a magnet be made up of a number of parallel magnetic whirls, all rotating in the same direction, it ought, like a gyrostat, to offer resistance to being twisted about. Experiment shows that no such resistance exists. The explanation offered by Dr. Lodge is that one half the rotations are right-handed, and the other half left-handed, as in the geared magnetic field surrounding the electric current.

To secure the uniform action of the whirls in the magnetic field, the ingenious hypothesis is made that one set of wheels or whirls is charged with positive electricity, and the oppositely rotating set with negative electricity. The negative rotation of negative electricity is considered equivalent to the positive rotation of positive electricity. We must confess we cannot imagine any fluid whose negative rotation will have the same effect as its positive rotation, and in this respect we think the theory is defective.

The author goes on to explain the difference between a dielectric and a conductor in their behaviour towards a magnetic disturbance. "In the dielectric the connection between the atoms is definite and perfect. If one rotates the next must rotate too; there is no slip between the geared surfaces. But in a metallic conductor the gearing is imperfect; it is a case of friction-gearing with more or less lubrication or slip, so that turning one wheel only starts the next gradually." In a perfect conductor the friction between the elements is absent, and the spin ceases to be transmitted at all. "The only possible current in a perfect conductor is a skin-deep phenomenon." It is by this slip that the energy of the wave in the dielectric is dissipated in the conductor. With a steady current the whirling motion penetrates to the centre of the conductor, and as the slip will be constant throughout, the heat generated in the conductor will be uniform across the whole section.

The phenomena of self-induction or electro-magnetic inertia are explained by means of the inertia of the dielectric, but our space will not permit us to go into this matter in detail. Current induction and magnetic induction are shown also to be due to a similar cause.

The fourth part of the book is devoted to the consideration of electrical Radiation or Light. Several reasons are given for supposing that the light wave is really an electric vibration. The speed with which an electro-magnetic vibration travels along a wire has been measured, and is found to correspond very closely with the velocity of light. A most ingenious argument is founded on the theory of the oscillatory discharge of the Leyden jar. The rate of oscillation in the Leyden jar discharge depends on the capacity of the jar and the self-induction of the circuit. Dr. Lodge has calculated the approximate size of a Leyden jar which would produce oscillations of a rapidity equal to that of the waves of light, and finds that it would have to be of atomic dimensions. The collisions of atoms would thus produce electrical vibrations of the same rapidity as the light waves; a fact furnishing very strong evidence in favour of the presumption that light is due to electrical oscillations in the atoms.

The author throws out the suggestion to practical men that light might be manufactured directly and economically by producing the electric oscillations by mechanical means.

When radiation encounters a conductor it is reflected, as the slip between the elements of the conductor prevents the vibrations from passing through it.

The electro-magnetic and electrostatic effects on light discovered by Faraday and Kerr, and the Hall effect, are discussed in the light of the new theory of the dielectric, but the explanation of these effects seems to be still somewhat unsatisfactory.

In conclusion, some recent interesting experiments by Hertz are described, which may be said to establish the identity of electro-magnetic and light waves, Hertz having reflected by metallic mirrors, and condensed by a lens of pitch, electro-magnetic waves of 6 inches in length, in exactly the same way as light is reflected and refracted.

Every electrician, we think, must feel indebted to Dr. Lodge for this popular and highly interesting exposition of the latest progress in a branch of science which is at the present time advancing with such leaps and bounds that only a specialist can hope to keep in the front rank.

CORRESPONDENCE.

Electric Traction.

In your issue of May 24th, in commenting upon Mr. W. D. Sandwell's system of electric traction, you very severely criticised the notion that there was any danger in placing the accumulators under the seats of the car. In fact, you applied the words "arrant nonsense" to such an idea. I intended to have written you giving my reasons for believing Mr. Sandwell's statement to be a correct one. Not great was my surprise, therefore, to learn from the letter of Mr. Th. Frazer, the secretary of the Electric Traction Company, in your paper of July 26th, that what Mr. Sandwell and those who thought with him had predicted had actually occurred on Monday, July 22nd, at the Green Gate, Plaistow; but I was surprised to find no editorial remarks on the matter, after what you had stated on May 24th.

Perhaps Mr. Frazer will be good enough to give some further details respecting this accident, as his account does not at all tally with the state of public knowledge regarding accumulators.

With your protest of May 24th—viz., that electric traction "is in danger of being misrepresented"—I am thoroughly in accord, and that is my reason for thinking that further explanation should be forthcoming.

Harry Willis.

August 3rd, 1889.

Overhead Wires.

Will you permit an old subscriber to enquire whether it is allowed in England to lead wires above ground for alternating currents of high tension for transformers, especially as regards towns of medium and large size?

Thanking you, in anticipation, for your reply,

Dan. Joh. Wades,
Hofrad.

July 30th, 1889.

[Many of the wires of the Grosvenor Gallery circuit in London are overhead, but the Electric Lighting Acts stipulate that in the future conductors shall be placed underground.—EDS. ELEC. REV.]

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